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Engineering News-Record

ROADS

Paved Road Design Developments.

Large vs. Small Road Contracts.

Highway Traffic Study in Connecticut.

Bituminous Roads in Kansas City Parks.

Special Methods in Using Slag for Concrete Roads.

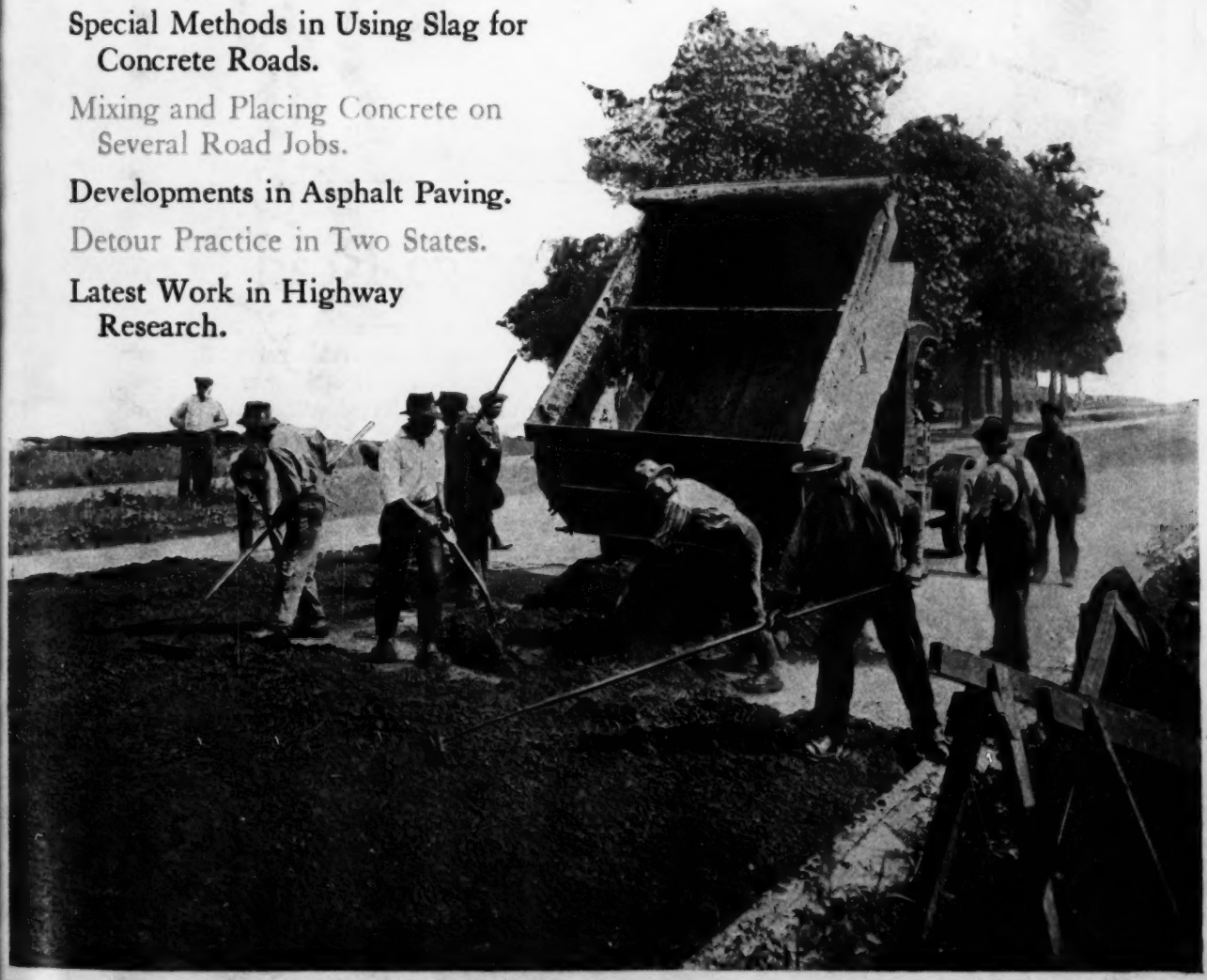
Mixing and Placing Concrete on Several Road Jobs.

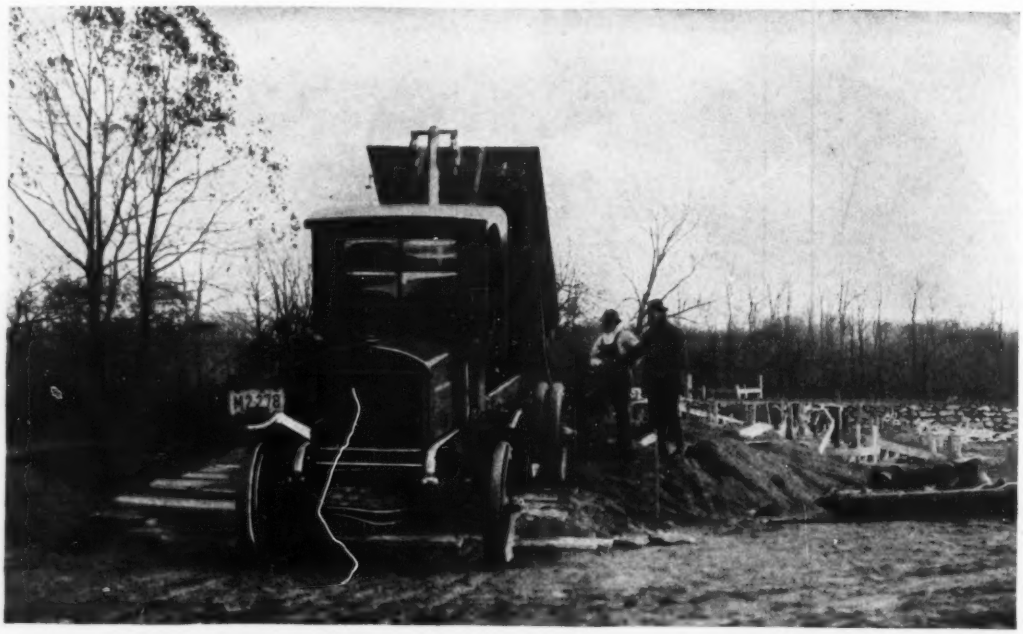
Developments in Asphalt Paving.

Detour Practice in Two States.

Latest Work in Highway Research.

Design
Construction and
Operation





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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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A Highway Number

APPEARING the week prior to the nineteenth annual convention of the American Road Builders' Association in Chicago, this issue is devoted in large part to articles in the highway field. In planning such an issue the editorial problem, as this journal interprets it, is not the amassing in large volume of contributed and staff articles relating to roadbuilding, but rather the selection of topics which are of outstanding interest to the specialists in this branch of engineering. There can be no doubt, at the present time, that highway engineers are directing more attention to economic and research subjects than to any others. For that reason these topics have been treated rather fully in articles relating to traffic matters, such as Connecticut's thoroughgoing vehicular census and the detour practice in Wisconsin and Maine. From the angle of technical investigation, the status of highway research is summed up and details are given regarding the pioneer work which the State of Illinois is doing. An examination of the issue will indicate, however, that the fields of highway design and construction have not been neglected and a business viewpoint is given by an article on the commercial and technical developments in asphalt paving and bituminous construction. Satisfaction of the desire to know what are the outstanding features of present-day highway practice and thinking, rather than yardage of highway reading matter, has been the special object of this issue.

For a Uniform Contract Form

IN THE NEWS PAGES this week are printed the suggestions of the Engineering Association of Nashville, Tenn., as to certain desirable clauses in a standard construction contract. These suggestions have been forwarded to the American Engineering Council and to the Associated General Contractors as an aid to them in the formulation of the general contract form which is being considered by various bodies following the conference called by Secretary Hoover a few weeks ago. This action by the Nashville engineers can well be followed by other engineering and contracting bodies. It is only by learning the consensus of engineering and contracting opinion throughout the country that the associated societies can produce a satisfactory standard document.

Connecticut's Traffic Study

THERE is nothing new in the taking of a census of vehicular traffic. Past efforts in this field, however, have been confined largely to a mere enumeration of passenger, commercial, and horse-drawn vehicles passing given points in certain periods of time. Some enthusiasm for this kind of a census was shown at first, but an attempt to apply the results in a practical way to the complex problem of rational highway development has demonstrated that the data thus secured were insufficient. Connecticut, however, under the direction of Commissioner Bennett, has recently completed a traffic census which is a step far in advance of anything of the sort that has been done in this country and which is made the subject of the leading article of this issue. Enlarging upon the scope of former surveys of traffic, the Connecticut investigations cover not merely an enumeration of vehicles, by types, but also detailed information regarding their weight, origin and destination, length of haul, character of loads, tire equipment and other facts of fundamental importance in guiding the future development of the state's trunk-line system. Pending a completion of the analysis of results, the article on p. 48 is limited to a description of scope of work, methods and total figures on traffic. The significant story will come later. For the present, however, highway engineers will be repaid by a study of the Connecticut methods. They represent a new milestone in traffic research, one of the most important subdivisions of the general field of highway economics.

Getting Under Way Promptly

DELAYS are so characteristic of large public undertakings that there is a refreshing effect about the smoothness and rapidity with which the Delaware River bridge project has been pushed along, to the point where the substructure work could be begun during the past week. The total time since the beginning of the engineering investigations for the undertaking is little more than a year, and it is only seven months since the report on the preliminary studies was rendered. Subsequent to that report, the hotly contested opinions among the public as to best location had to be fought out, and, after the location recommended by the engineers had been agreed upon by all, the tentative structural design had to be restudied, revised and brought into working shape. Thus there was much work to do. None of the items of the work were simple or conventional moreover; the planning of the enormous foundation caissons, for example, could not be hurried through as a routine job. Yet the plans for the substructure were ready for bidding nearly three months ago, and bids were received by the middle of December. Public works directed by commissions do not often move so fast, especially where joint action of two states is involved. The Pennsylvania and New Jersey commissions responsible for the Delaware bridge are entitled to commendation for what they have accomplished.

Thrift Week

FOR SOME YEARS the Y. M. C. A. has been doing a worth while work in promoting thrift. In addition to its continuing activities, it tries once a year to make thrift dramatic. That effort coincides with Benjamin Franklin's birthday. Accordingly Thrift Week begins next week, on Jan. 17, the anniversary of Franklin's birth. Each day has a different emphasis. The first is on thrift itself and the next five on the value of keeping

personal budgets, of life insurance, of owning one's own home, of paying bills promptly and of making a will. The Sunday within the week has the unselfish emphasis, the obligation of sharing with others. Already the results of the association's thrift propaganda have been notable. A long list of accomplishments in almost every part of the country is publishing by the committee in charge of the work. The idea deserves personal application and the personal support of every reader of *Engineering News-Record*. A thrifty America is quite certain to be a sane, a healthy, and surely a prosperous, America.

Slag Concrete For Roads

USE on a large scale of slag as an aggregate for concrete roads is described in this issue. Contractors will observe that slag in this instance was found to be a less workable aggregate than is gravel and crushed stone. It was not so easy to handle out of bins and in chutes. The mixture required to be worked more to finish the slab. Finally a workable mixture had to be determined by juggling the proportions until they gave the required smooth product. When once the methods were adjusted to the material the difficulty of handling it was not substantially greater, but an adjustment was necessary. Old methods were not adequate. This is a condition in slag concrete road construction which contractors have to bear in mind, for slag in some districts offers a distinct advantage in price and availability.

Better-Made Construction Equipment

MANUFACTURERS report the significant fact that they are finding it increasingly possible to put weight and quality into construction equipment with a reasonable expectation of selling the machines. The inference is that contractors are buying equipment on the basis of a continuing business, much as a manufacturer buys tools for his shops, and not on the basis that each job stands alone and must cancel its own equipment investment. There are other signs pointing to the same conclusion. Prominent among them is the development of rental and depreciation schedules by contractors' associations. Contractors individually are paying more attention to the selection, operation and maintenance of equipment by employing plant managers or machinery superintendents. A great advance is yet necessary before contractors are managing their equipment investment in the really efficient manner in which it is managed in almost any factory. But there is progress. Better constructed equipment is one of the signs of this progress. Contractors are learning that steel instead of iron and cut gears instead of cast gears are worth paying for if they propose to continue in contracting longer than the job in hand.

Active Season for Highways

HIGHWAY contractors and manufacturers of road machinery should draw encouragement from the forecast of 1922 highway construction, which was published last week. In 1921 a total of $420,000,000 was spent in construction. It is estimated that the present year's expenditures will be as large and may quite likely be considerably larger. With the same expenditure in 1922 as in 1921, more miles of highway will be constructed because costs have decreased in different localities from 10 to 30 per cent, probably not far short of 25 per cent as an average. It is miles of highway built rather than dollars expended which determines the opportunity for contractors and equipment manufacturers. All signs, therefore, indicate plenty of work for highway contractors and an active market for road machinery during the coming season.

Double Shifts in Road Building

PAVED-ROAD contractors should consider carefully the possibilities of working double shifts. The practice is reported to have been highly successful in the few instances where it has been attempted this year. In one concrete-road operation the normal season's progress with a standard paving mixer and finishing machine outfit was practically doubled. It is quite reasonable to expect such a result. Concrete roads are essentially machine-built structures. Slab fabrication proper is a sequence of machine operations constituting virtually a field factory process. When a factory manager wants to increase production he works two or three shifts of men, using the machines which he has more intensively. Only when this resort fails to meet the demand for production does he consider adding to his equipment. The road contractor has apparently always felt that he must increase his plant when he wanted to hasten production. Logically he should be even more alert than the factory manager to capitalize as rapidly as possible on the machinery which he has. His season of paying production is shorter and he cannot produce ahead and store his product for future demand. His loss through depreciation by obsolescence is more rapid even than that of the manufacturer, since improvements in construction equipment are more rapid and the gain in operating constantly new equipment is greater. In these respects and in others which come easily to mind, double shifts promise a way out of a number of difficulties which beset paved-road contracting.

The Genoa Conference

THE EXPECTED is to come about. Europe, including all of the former belligerents, is to be invited to an economic conference in Genoa in March. Even Russia is included. Though it is expected that the United States will be invited, it is very apparent that the European premiers have concluded that if the United States declines, or merely sends one of its innocuous listeners, they must go ahead and work out their economic salvation with their own resources.

This is indeed good news even though the need for an economic conference has long been realized. There is some regret that the United States has not taken the leadership. She is to a large extent the world's banker. Many of the European nations are indebted to her. She would, therefore, have a tremendous influence in the deliberations.

Against this regret that the United States is not to have a major part must be off-set the satisfaction from knowing that Europe feels that she can with her own resources compromise her economic difficulties. A year ago America was believed to be the only savior. No European statesman can be so dumb as to fail to see that drastic measures alone will avail, and that those drastic measures must be taken immediately. If there can be preliminary accord between England and France, followed by an early acceptance by Germany of a policy of balancing her budget, the other financial inter-relations ought to be possible of satisfactory arrangement.

The case of Russia, however, stands out as the one impossible factor. Yet even Russia is in such dire stress that there is hope that she will be glad to exchange a hopeful practical policy for a bankrupt theoretical one. Looking forward to her entrance into the conference, the Supreme Council of the League of Nations last week laid down at Cannes the conditions of her entrance. Obviously there cannot be trade relations with her nor Russian investments of foreign capital unless property rights are respected and contracts are enforced. These conditions Russia is asked to accept. As a necessary corollary, and as a condition precedent to French dealings with Russia, there is also demanded recognition of the former Imperial Russian debt. Finally, she is asked to agree to abstain from propaganda subversive of the political systems of other countries. The great problem of the moment in international affairs is whether Russia will accept these terms. To other nations they would seem easy. To Russia they are hard, for they require abandonment of the whole basis of the Bolshevist system. Nevertheless, the bankruptcy of Bolshevism is apparent even to the Bolshevist leaders, as is evidenced by their recent capitalistic overtures. There is ground for hope that Russia will sit in at the Genoa Conference.

Despite the natural pessimism regarding the results of international meetings, it would seem impossible for the Genoa Conference to be entirely abortive. Conditions are so bad that even large compromises should be easy of attainment. Certainly the Washington results furnish an excellent example.

Large-Mileage Highway Contracts

WITH millions available for paved road construction and a traveling public demand that this construction shall be rushed, careful consideration is required of the claim being urged that large-mileage contracts will both hasten and cheapen the work. In an inquiry, which has required several months to complete, evidence and opinion on large-mileage contracts have been gathered from some scores of highway engineers and contractors, equipment manufacturers and state executives. The conclusions arrived at will be found in this issue.

That the conclusions given are not categorical and definitive will disappoint the extreme advocates and opponents of large-mileage contracts. It is likewise certain, however, that the majority of engineers and contractors will see in their indefinite and tentative character a true reflection of the conditions imposed on highway development by political, financial and social policies and practices which cannot easily be set aside to make the way clear for a straightforward engineering and business solution.

Few state highway engineers can lay out improved highways as they wish or are free to determine the time and sequence of construction. Law and custom curtail their freedom on all sides and, of the two, custom offers the most binding shackle. Local initiative in highway development has almost the force of a fetish in the popular mind, particularly in the south and west where for years to come the great construction records in paved roads are to be made. Unhampered centralized control of highways, without which large-mileage contracts cannot become a general construction policy, is a doctrine to which the people have yet to be converted in a large part f the United States. Even many of our states, such as Kansas and Texas, lack this control.

With the conditions as related, it is plain that large-mileage contracts have to demonstrate their economy so convincingly that the public can be swung from its allegience to local determination of highway improvement and converted to centralized initiative and control. It is also plain, from the statements in the article referred to, that the first steps in this task have been scarcely initiated. Highway engineers have not yet had the proof that satisfies them that large-mileage contracts offer enough advantages over present practice to warrant any particular effort toward their adoption.

With all that has been said it is obvious to any engineer that the large mileage contract has its place in highway construction. When and where it can be employed to advantage is an engineering question to be answered in each instance by balancing the probable gains and losses.

Highway Detour Practice

HANDLING vehicular traffic through or around construction work—detour practice, as it is commonly known among highway engineers—has developed into one of the major problems of the state highway departments. Until recently the matter was generally regarded as merely an unimportant incident in road construction. This attitude was responsible for such great inconveniences to the traveling public and for such a widespread storm of criticism that a new conception of the relative importance of detours has developed. As indicative of the new attitude attention is invited to two articles in this issue, one representing western practice, by Mr. Hirst of Wisconsin, and the other eastern practice, by Mr. Sargent of Maine.

Service to traffic is today's slogan in highway administration. So vital a part do highways play in our industrial life that the barricading of a route under construction without provision of good detours, or by-passes, can no longer be tolerated. There are two alternatives, the first to send traffic through the work under construction by building the new roadway in halves, and second, to divert it to other routes. Much importance attaches to the making of a correct decision, particularly when it is realized that the routing of the traffic through the contract adds, according to competent estimates, 25 per cent to construction costs. If this procedure is not followed, however, it is clear that with the number of vehicles using our highways today considerable sums must be spent in preparing and maintaining the detour routes. That also involves the expenditure of considerable sums.

Mr. Sargent has some very pertinent comments on this phase of the subject. His proposed solution of the problem, by employing the money now spent on detours for the widening of existing roads so that traffic may be passed through construction work with a minimum disturbance to such operations, is radical and furnishes abundant proof, if any is now needed, that the subject of detouring demands the same kind of study as other traffic problems.

As was pointed out in an editorial note in this journal some time ago, detouring can be the best or the worst form of advertising in which a state highway department may engage. It establishes a direct point of contact with the public and many of the state departments, as exemplified by Wisconsin's practice, have realized the necessity of marking detours with signs properly placed so as to guide traffic to its destination.

Connecticut Makes Detailed Study of Highway Traffic

Fourteen-Day Census at State Lines Yields Data on the Number, Weight, and Size of Vehicles, Lengths of Haul and Character of Product Shipped by Truck—Airplane Photo to Be Made

TRAFFIC studies involving not merely counts of the number of vehicles, but the collection of data on gross weight, width and condition of tires, character of product shipped, point of origin and destination, and dimensions of trucks have been completed by the Connecticut State Highway Department and, according to plans just announced by Commissioner Charles J. Bennett, are to be supplemented at an early date by airplane photographs designed to indicate the distribution of traffic on some of the state's most intensively traveled trunk-line highways. The field work, undertaken at two traffic-recording stations equipped with platform

WEIGHING TRUCK AND TAKING TIRE WIDTH BY IMPRINT ON PAPER

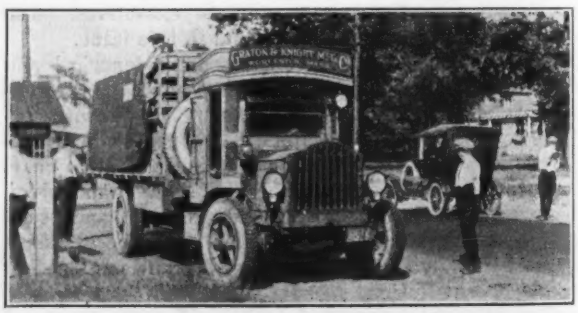
weighing scales located just inside the state boundary lines separating Connecticut from New York on the west and Massachusetts on the north, covered 14-day periods in August and October, 1921, and supplied a mass of data which is now being digested by the U. S. Bureau of Public Roads, with which the Connecticut department is co-operating in its program of traffic investigation.

In point of broadness of scope and completeness of information secured, the studies mark a new epoch in highway transport research. Conclusions, however, must await the detailed analysis of the data. As Commissioner Bennett expresses it, Connecticut at present is in the position of a hen hatching out a nest-full of eggs and is not yet in a position to count its chickens. It is possible, however, to indicate the methods employed in making the traffic studies and the total number of vehicles recorded. In line with this work, but not directly a part of it, observations were made on the use of the highways leading to and from New Haven on the day of the great football classic, the Yale-Princeton game, staged in the Yale Bowl, which is credited with a capacity of 80,000 spectators.

The Connecticut traffic studies are the result of a realization, gained from previous traffic census work in which only the number of vehicles of various types were recorded, that more complete information is needed if the results are to be applied in a practical way to economic highway development. About a year ago the general subject was discussed at a conference of state and federal higway officials out of which developed the drafting of an outline of a highway research program, designed to indicate all of the elements entering into the problem of highway transport and convering the broad subjects of engineering, including the vehicle and the road; transportation economics; administration; and finance. This outline was published in *Engineering News-Record*, Sept. 15, 1921, p. 450. With the approval of Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, Connecticut undertook to supply some of the information called for in this research program and, accordingly, comprehensive plans were developed for a study of traffic, extending over a period of two weeks, at two widely separated points near the state's boundary lines.

Connecticut, with an area of 5,004 sq.miles and dimensions, measured on lines through Hartford, the state capital, of about 85 miles east and west and 55 miles north and south, is essentially a manufacturing state, and is relatively unimportant from the point of view of agricultural products. Its factories turn out a wide variety of foundry and machine-shop products, especially brass goods, hardware of all sorts, textiles, sewing machines, watches and clocks, nails, fire-arms and ammunition, rubber products, hats, needles, tinware, silverware, and a host of other products, for the most part small, heavy, and expensive.

The state's great industrial activity, coupled with its location midway between two of the greatest Eastern markets, New York City and Boston, creates very especial conditions of highway transport. Hartford, the capital, located about in the center of the state, is only 115 miles distant, by highway, from New York (via New Haven), and 125 miles (via Springfield) from Boston, both of these trips being within the economical operating radius of motor trucks. The result has been



GETTING REAR AXLE TRUCK WEIGHT

the development of an unusually heavy volume of interstate truck traffic. The State Highway Department, therefore, is confronted with the problem not merely of building and maintaining roads to handle motor-truck shipments originating in Connecticut, but also of carrying the traffic which crosses the state in trips between New York, Massachusetts and Rhode Island.

Actual counts have indicated a traffic intensity as high as 8,000 vehicles in 10 hr. on an 18-ft. road. The total length of highways of all types in Connecticut is about 12,000 miles and the State Highway Department

INTERROGATING PASSENGER CAR DRIVERS

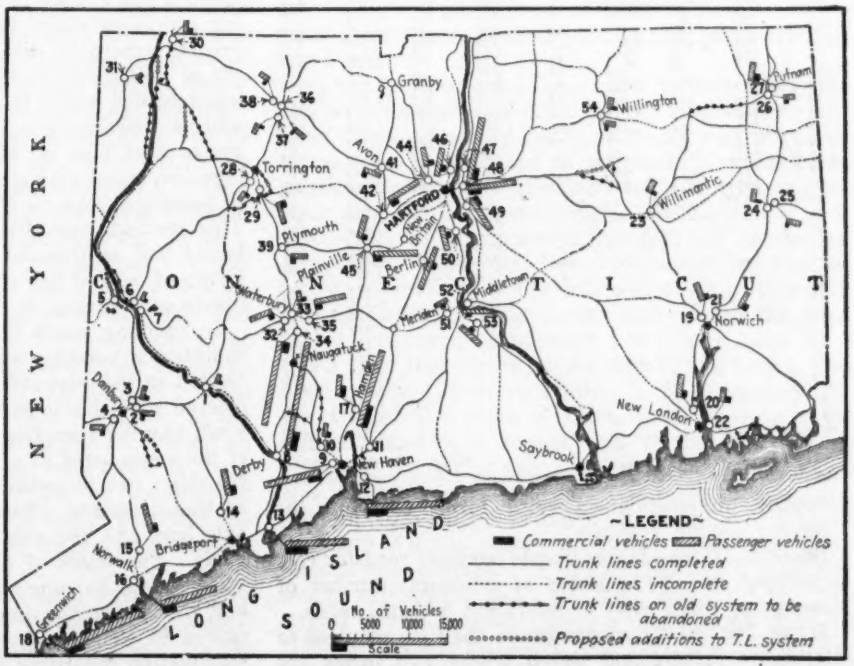
estimates that 90 per cent of all traffic is carried on 900 miles of road, or 7½ per cent of the total mileage. The critical elements in the Connecticut transportation situation, therefore, relate to the relief of traffic congestion by proper distribution, the regulation of motor trucks as regards weight, size and speed, the determination of a scale of license fees adequate to provide for the maintenance of the highways and the planning of new construction or reconstruction, with respect both to location and type of surface, so as best to serve the traffic needs of the future.

As a preliminary to the detailed traffic studies, a three-day count of vehicles at 56 observation posts distributed throughout the state was made, beginning at 12.01 a.m., Saturday, April 30, and continuing until midnight, Monday, May 2, 1921. Table I and the accompanying map show the results of this survey. The greatest volume of traffic was observed at Station 8, at Derby on the route leading to New Haven; for the three days the count showed 14,378 passenger automobiles and 2,445 motor trucks. At Station 18, on the Boston Post Road at Greenwich, 11,482 passenger cars and 2,088 motor trucks passed during the three days. At Station 34, on the Naugatuck Road, between Waterbury and New Haven, third in point of traffic volume, the results were 11,573 passenger cars and 1,123 motor trucks. For a single day the greatest number of passenger automobiles on one road was 6,173 (on a Saturday) and of motor trucks, 1,169 (on a Monday). In general, the results showed a total traffic at all stations for the three days of 203,966 passenger cars and 36,572 motor trucks.

While records such as those secured in the May census, cited above, are useful as an index of traffic conditions, they do not supply the data required, according to Connecticut's highway commissioner, to reach a comprehensive understanding of the relations between traffic and highway development. Numerical counts, by themselves, disclose many vagaries which are unexplainable without additional information. Between two important centers in Connecticut, for instance, there are two roads not more than a mile difference in length and on an equality so far as surface conditions are concerned, one route, apparently, being as desirable as the other. Yet the traffic on the newer road does not amount to one-half of that on the older route. Such cases are not uncommon and they may lead, in Commissioner Bennett's opinion, to the necessity of adopting some form of train-dispatching system to produce a more even distribution of motor-truck and passenger automobile traffic on the state's trunk lines. In the case of trucks regularly operating between certain points day after day it may be necessary for the state highway commissioner or the motor vehicle department to specify routes to be followed. Such means appear to be the only feasible way of relieving present congestion and conserving the highway system.

For making the detailed traffic studies two recording stations were established, one at Greenwich, on the Boston Post Road, near the New York State line and the other at Enfield, on the east bank of the Connecticut River close to the Massachusetts State line and directly south of Springfield, Mass. At each station platform scales were located, the one at Greenwich being of 25 tons capacity and the one at Enfield 10 tons capacity. The 25-ton capacity scales are the type preferred, the lighter 10-ton unit having been only a temporary installation. The heavy scales have a platform about 10 ft. wide and 24 ft. long, and are equipped with a large dial; the operation consists in adding weights, by means of a hand lever device, to the nearest 4,000 lb. after which the scale balances itself automatically. The advantage in having the weights recorded on a large dial lies in the fact that the driver can see the result of the weighing and it is less likely that he will argue about it.

Plans for the traffic census provided for securing the



LOCATION OF RECORDING STATIONS, TRAFFIC CENSUS OF APRIL 30-MAY 2, 1921 (SEE TABLE I)

TABLE I—CONNECTICUT TRAFFIC CENSUS

Taken from 12:01 A.M. Saturday, April 30 to 12:00 Midnight, Monday, May 2, 1921; locations of stations as shown on map, p. 49.

Sta. No.	Sat., April 30		Sunday, May 1		Monday, May 2		Total	
	Pass'gr.	Commercial	Pass'gr.	Commercial	Pass'gr.	Commercial	Pass'gr.	Commercial
1	.....	.....	.....	...	.....	.....	998	115
2	.....	.....	.....	...	.....	.....	1,881	291
3	.....	.....	.....	...	.....	.....	1,739	278
4	.....	.....	.....	...	.....	.....	1,968	344
5	.....	.....	.....	...	.....	.....	189	26
6	.....	.....	.....	...	.....	.....	1,377	186
7	.....	.....	.....	...	.....	.....	434	89
8	6,173	1,084	4,674	192	3,531	1,169	14,378	2,445
9	3,004	709	2,983	301	2,080	598	8,067	1,608
10	511	102	702	94	458	119	1,671	315
11	2,845	1,074	4,265	416	2,894	1,224	10,005	2,714
12	3,303	1,025	4,012	290	2,929	940	10,244	2,255
13	2,847	967	3,861	590	3,016	1,114	9,724	2,671
14	1,174	321	1,277	171	872	308	3,323	800
15	659	223	1,775	184	1,099	234	3,533	641
16	2,158	600	3,029	273	2,337	598	7,524	1,471
17	801	444	1,127	50	772	468	2,700	962
18	2,007	930	6,610	224	2,865	934	11,482	2,088
19	621	164	1,078	88	688	181	2,387	433
20	944	206	1,078	132	898	246	2,920	584
21	580	136	712	113	517	146	1,809	395
22	265	200	496	79	304	140	1,065	419
23	410	113	707	200	512	79	1,629	392
24	448	20	483	17	393	56	1,324	93
25	622	67	435	36	351	84	1,408	187
26	669	229	636	71	638	412	1,943	712
27	427	160	489	59	441	130	1,357	349
28	320	140	656	20	399	68	1,375	228
29	561	122	1,761	122	624	331	2,946	575
30	419	94	417	48	372	157	1,208	299
31	362	79	364	30	238	62	934	171
32	988	199	1,227	46	896	179	3,111	424
33	796	206	1,265	95	879	262	2,940	563
34	3,541	425	4,645	148	3,387	550	11,573	1,123
35	1,271	354	1,784	102	1,155	207	4,210	663
36	515	50	857	20	423	102	1,795	172
37	357	56	675	26	297	92	1,329	174
38	372	51	607	18	274	71	1,253	140
39	661	127	972	32	559	144	2,192	303
40	.....	.....	.....	...	.....	.....	251	38
41	.....	.....	.....	...	.....	.....	2,470	278
42	.....	.....	.....	...	.....	.....	4,444	590
*43	.....	.....	.....	...	.....	.....	3,020	379
44	.....	.....	.....	...	.....	.....	2,264	342
45	.....	.....	.....	...	.....	.....	5,973	632
46	.....	.....	.....	...	.....	.....	3,444	561
47	.....	.....	.....	...	.....	.....	8,121	1,202
48	.....	.....	.....	...	.....	.....	6,570	1,267
49	.....	.....	.....	...	.....	.....	5,017	1,028
50	.....	.....	.....	...	.....	.....	3,186	387
51	.....	.....	.....	...	.....	.....	1,914	282
52	.....	.....	.....	...	.....	.....	4,021	550
53	.....	.....	.....	...	.....	.....	3,132	418
54	.....	.....	.....	...	.....	.....	1,167	107
54	.....	.....	.....	...	.....	.....	1,004	93
*43	.....	.....	.....	...	.....	.....	6,923	620
						Total....	203,966	36,572

*Night census.

following information on ruled forms carrying the following column headings:

Passenger Cars—Make; license number; roadster (R) or touring car (T); number of cylinders; number of passengers; time; start of haul; end of haul; miles.

Motor Trucks—To economize on the time required to interrogate drivers and weigh trucks two forms are filled in by different men as follows:

Form 1: License number and state; make; time; capacity in tons; loaded (L) or empty (E); estimated time required for trip; name of truck owner; name and address of consignor; name and address of consignee; length of haul in miles; character of load; direction of traffic; regular or irregular trip.

Form 2: License number and state; make; time, total width of body; weight on front axle; weight on rear axle; tires, solid (S), cushion (C), dual (D), or pneumatic (P); width in inches and type of front tire; width in inches and type of rear tire; thickness of tire (channel to road surface); condition of tires.

Motorcycles—License number; single (A), or side car (B); number of passengers; time; location of start of haul; location of end of haul; miles.

Horse-Drawn Vehicles—Passenger (P) or freight (F); number of horses; commodity carried; tonnage; time; location of start of haul; location of end of haul; miles.

In all cases record was made of the date and weather conditions. Sheets of paper, properly ruled into columns, with blank spaces provided for inserting the information called for by the headings, were prepared.

As typical of the methods employed in securing the information on traffic, the methods employed at the Enfield station will be described. The force consisted of seven men, of which three were located at the scales to secure data on the motor trucks and two men on each side of the road to handle the passenger car traffic. One hundred feet on each side of the recording station large painted signs carrying the following legend were erected: "Connecticut State Higway Department. Traffic census for U. S. Bureau of Public Roads."

By means of these signs the traveling public was acquainted with the object of the subsequent stopping of their cars and questioning, and practically no objection was made.

In the first scheme of handling the passenger cars each one of the pair of men on either side of the road handled every other car, the delay due to the questioning averaging about 15 sec. per car. The men quickly became expert in determining the make and type of car at a distance, so that a portion of the information was recorded before the car was actually stopped. This scheme, however, was later modified by having one of the pair of men on each side of the road act as an observer, who called out all of the information relating to passenger cars, to the other, who acted as recorder. This method was ultimately adopted for both northbound and southbound passenger car traffic. With a string of cars in line it took from 8 to 10 sec. to interrogate each passenger car driver by this method.

In handling motor trucks at the Enfield station, only southbound vehicles were weighed, as the scales were located on the west side of the road and it was not considered advisable to send northbound trucks across the road, thereby impeding traffic. One of the three men at the scales acted as a recorder of the information and the other two attended to the weighing and the taking of measurements. Two weighings, one for the front axle load and the other for the rear axle load, were made. The width of the bearing surface of the tires was obtained by running the trucks over sheets of paper and measuring the imprint. The length of time required to weigh each truck and secure the necessary information regarding it varied from 1 to 1½ min. An economy of time was effected by questioning the driver while his truck was being weighed.

While northbound trucks were not weighed at Enfield, the other information called for in the blank forms was procured. In order to prevent delay trucks were sent about 100 ft. beyond the scales and at that point their drivers were queried either by one of the men from the scales or an additional recorder. During periods of unusually heavy passenger traffic, as on Saturday afternoons and Sundays, truck traffic was light and men ordinarily assigned to the scales took notes on passenger traffic. Information regarding motorcycles and horse-drawn vehicles was secured by the force detailed to passenger car traffic. It involved very little work as the traffic of these types was so light as to be almost negligible.

Records of traffic by night were included in a continuous period of census-taking from the morning of Aug. 22 to the evening of Aug. 24, totaling 56 hours. Two men handled the night work. On the night work

TRAFFIC CENSUS AT ENFIELD, NEAR CONNECTICUT—MASSACHUSETTS STATE LINE—AUGUST 16-29, 1921.

Date, 1921	Hours Census was Taken	Passenger Cars			Motor Trucks			Motor Cycles			Horse-Drawn Vehicles			Total Vehicles
		South Bound	North Bound	Total	South Bound	North Bound	Total	South Bound	North Bound	Total	South Bound	North Bound	Total	
Aug. 16	8 a.m.—6 p.m.	774	751	1,525	119	107	226	10	17	27	2	3	5	1,783
Aug. 17	8 a.m.—6 p.m.	755	766	1,521	116	82	198	7	7	14	5	6	11	1,744
Aug. 18	8 a.m.—6 p.m.	699	696	1,395	129	114	243	5	7	12	2	1	3	1,653
Aug. 19	11 a.m.—9 p.m.	932	914	1,846	104	103	207	9	8	17	2	2	4	2,074
Aug. 20	8 a.m.—6 p.m.	1,064	1,030	2,094	83	98	181	18	21	39	4	3	7	2,321
Aug. 21	6 a.m.—4 p.m.	1,755	1,218	2,973	28	27	55	29	9	38	1	1	2	3,068
Aug. 22	8 a.m.—6 p.m.	784	837	1,621	128	80	208	8	8	16	2	1	3	1,848
Aug. 22 and 23	*6 p.m.—6 a.m.	300	308	608	29	36	65	....	....	....	....	....	....	673
Aug. 23	*6 a.m.—4 p.m.	698	591	1,289	118	103	221	5	7	12	2	2	4	1,526
Aug. 23 and 24	4 p.m.—6 a.m.	462	498	960	18	13	31	....	....	....	....	....	....	991
Aug. 24	6 a.m.—4 p.m.	672	658	1,330	74	78	152	8	4	12	3	1	4	1,498
Aug. 25	11 a.m.—9 p.m.	854	822	1,676	81	89	170	8	8	16	....	6	6	1,868
Aug. 26	11 a.m.—9 p.m.	875	924	1,799	84	80	164	5	4	9	2	5	7	1,979
Aug. 27	8 a.m.—6 p.m.	1,092	1,022	2,114	69	75	144	22	9	31	4	3	7	2,296
Aug. 28	9 a.m.—7 p.m.	1,857	1,862	3,719	13	18	31	28	38	66	3	7	10	3,826
Aug. 29	11 a.m.—9 p.m.	784	785	1,569	63	36	99	13	12	25	5	5	10	1,703
		14,357	13,682	28,039	1,256	1,139	2,395	175	159	334	37	46	83	30,851

*Night census.

only those trucks were weighed which carried exceptionally heavy loads.

Speed tests of trucks were taken on two days, Aug. 20 and 22. A concealed observer was stationed on one side of the road with two sighting points on the opposite side, so spaced that the speed in miles per hour was determined by dividing 100 by the observed time of passage, in seconds, between the two points. Truck speeds generally ranged from 15 to 20 miles per hour.

The Connecticut law limits the gross weight of a motor truck to 25,000 lb. and the weight per inch width of tire to 800 lb. The weighing operations disclosed a number of overloads. It is worth noting that the fines collected paid for the cost of the 25-ton scales—about $2,700—within a period of two weeks. The greatest overload was noted on a truck of 2 tons capacity, the unladen weight of which was 5,000 lb., giving a total allowable gross weight of 9,000 lb. The actual gross weight of this truck, as shown by the scales, was 18,040 lb., equivalent to an overload of 9,040 lb., or 225 per cent. A fine of $100 was imposed in this case. Another 5½-ton truck whose unladen weight was 12,000 lb., giving an allowable maximum gross weight of 23,000 lb., was found actually to weigh 31,120 lb., an overload of 8,120 lb., or about 70 per cent. A fine of $200 was imposed in this case. Another 5-ton truck was overloaded 8,920 lb.

At the two traffic-recording stations, during the two 14-day periods, in August and in October, the total vehicles counted numbered 75,155, as shown in the accompanying tables. Of this number, 66,777, or 89.0 per cent, were passenger automobiles; 7,342, or 9.7 per cent, motor trucks; 764, or 1.0 per cent, motorcycles; and 272, or 0.3 per cent, horse-drawn vehicles. During a single day the greatest volume of traffic reported was 5,784 vehicles from 8 a.m. to 6 p.m. Oct. 16 at the Greenwich station; this was a Sunday, on which the passenger cars numbered 5,586 and the motor trucks only 56. On week days at this station it was not unusual to have more than 400 trucks pass between 8 a.m. and 6 p.m.

At the present time it is possible to give merely the number of vehicles recorded at the two stations and their classification as to types. The real story, of course, will be contained in the analysis of tonnages, length of haul, origin and destination of trip, and the other data secured in the detailed census.

It is pointed out, in connection with the October results, at the Connecticut-New York state line, that the period covered is at the tail end of the automobile touring season and that during mid-summer the number of passenger automobiles would have been much larger than that shown in the table. The Boston Post Road at the Greenwich station is of Warrenite construction, with a width of 21 ft., while the road at the Enfield station is of Topeka type, 18 ft. wide.

During the day of the Yale-Princeton football game, Nov. 12, 1921, a traffic census was taken at seven stations on roads leading in and out of New Haven between the hours of 8 a.m. and 8 p.m., during which time 26,016 vehicles were counted. Of this number 24,022 were passenger automobiles and 1,499 were motor trucks. The largest volume of traffic during a single hour was on the Milford Turnpike leading to New York, and amounted to 1,619 vehicles between the hours of 5 and 6 p.m., following the conclusion of the game; of this number 1,601 vehicles were passenger cars (1,569 outbound and 32 inbound) and 15 were motor trucks. The Milford

TRAFFIC CENSUS AT GREENWICH, NEAR CONNECTICUT—NEW YORK STATE LINE—OCTOBER 3-16, 1921

Date, 1921	Period, Hours	Weather	Passenger Cars			Motor Trucks			Motor Cycles			Horse-Drawn Vehicles			Total Vehicles
			East Bound	West Bound	Total	East Bound	West Bound	Total	East Bound	West Bound	Total	East Bound	West Bound	Total	
Oct. 3	8 a.m.—6 p.m.	Rain	1,036	1,176	2,212	220	220	440	2	4	6	3	3	6	2,664
Oct. 4	8 a.m.—6 p.m.	Fair	1,036	1,288	2,324	214	202	416	5	16	21	5	5	11	2,772
Oct. 5	8 a.m.—6 p.m.	Fair	1,120	1,280	2,400	194	217	411	4	7	11	5	14	19	2,841
Oct. 6	8 a.m.—6 p.m.	Fair	1,142	1,288	2,430	178	240	418	5	9	14	12	14	26	2,888
Oct. 7	6 a.m.—4 p.m.	Fair	974	1,060	2,034	184	237	421	5	7	12	9	3	12	2,479
Oct. 8	6 a.m.—4 p.m.	Cloudy and rain	1,190	1,064	2,254	201	183	384	19	7	26	5	6	11	2,675
Oct. 9	6 a.m.—4 p.m.	Fair	2,086	1,694	3,780	43	30	73	35	20	55	3	5	8	3,916
Oct. 10	10 a.m.—8 p.m.	Fair	1,120	1,176	2,296	209	215	424	11	18	29	8	16	24	2,773
Oct. 10	*8 p.m.—8 a.m.	Fair	198	206	404	50	72	122	....	....	....	....	....	....	526
Oct. 11	*8 a.m.—6 p.m.	Fair	997	1,186	2,183	166	197	363	4	19	23	6	8	14	2,583
Oct. 11	6 p.m.—6 a.m.	Fair	568	262	830	77	28	105	8	7	15	1	2	3	953
Oct. 12	6 a.m.—4 p.m.	Cloudy	1,386	1,134	2,520	98	72	170	12	9	21	2	6	8	2,719
Oct. 13	6 a.m.—4 p.m.	Fair	672	1,064	1,736	185	216	401	8	10	18	6	9	15	2,170
Oct. 14	10 a.m.—8 p.m.	Fair	1,199	1,120	2,319	223	207	430	8	11	19	4	9	13	2,781
Oct. 15	9 a.m.—7 p.m.	Fair	1,806	1,624	3,430	157	156	313	10	15	25	4	8	12	3,780
Oct. 16	8 a.m.—6 p.m.	Fair	2,744	2,842	5,586	39	17	56	34	101	135	5	2	7	5,784
			19,274	19,464	38,738	2,438	2,509	4,947	170	260	430	78	111	189	44,304

*Night census.

Turnpike is of concrete type construction and has a width of travel surface of 18 ft. During the 12 hr. period from 8 a.m. to 8 p.m. at this traffic recording station, a total of 8,051 vehicles was recorded. The counts during the 12 hours at the other six stations were: 4,152; 3,310; 2,734; 3,368; 2,763; 1,638. An analysis of the total of 26,016 vehicles during the day showed passenger cars inbound, 11,827; passenger cars outbound, 12,195; total passenger cars, 24,022; motor trucks inbound, 766; motor trucks outbound, 733; total motor trucks, 1,499; motorcycles inbound, 108; motorcycles outbound, 107; total motorcycles, 215; horse-drawn vehicles inbound, 131; horse-drawn vehicles outbond, 149; total horse-drawn vehicles, 280.

The foregoing results of traffic on the day of a big football game, it should be understood, are merely an incident in the Connecticut studies and do not form an essential part of the detailed census, the results of which are now under analysis. As a supplement to the latter work, however, Commissioner Bennett has completed arrangements for the taking of a series of airplane photographs on the road leading from Bridgeport, Conn., to New York by way of Greenwich. This is one of the state's heavily traveled trunk line routes and the object of the aerial photographs will be to show the distribution of traffic and to indicate the points where improvements are needed. A stretch of about 30 miles is to be covered and with the relative speed of the airplane and the fastest moving automobiles estimated at 75 and 30 miles per hour respectively it is believed that much illuminating information can be secured.

Bucket Loader Charges Batch Boxes From Stock Piles

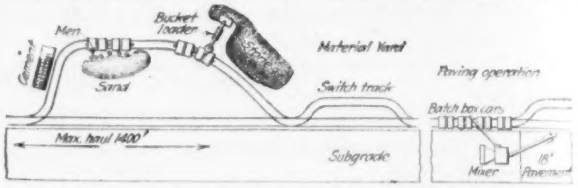
INDUSTRIAL railway haulage was operated with success last year on the Detroit-Chapman road in Dickenson County, Kansas, by stock-piling at frequent intervals and rehandling the material with a bucket loader. This road is 6 miles long with a pavement of 1:2:3½ concrete 18 ft. wide, 8 in. thick at the center and 6 in. thick at the edges.

As the stone was crushed at a small plant having a capacity of only about 100 cu.yd. per day, located 1½ miles from Chapman, it was necessary to delay beginning construction until considerable material had been stock-piled. These stock-piles were made along the highway at intervals of about 2,800 ft. on pieces of land rented for that purpose. The sand was pumped from the river approximately three-quarters of a mile from the road at a point one mile east of Detroit. This also was piled near the stone previous to beginning construction. When sufficient material had been stock-piled to insure continuous operation the paving was started. The hauling was done both by truck and by team, depending on the conditions and the availability of each.

Frequent stock-piling was adopted to reduce the investment to a minimum. It also provided an unlimited storage of material comparatively close to the paver; eliminated the excessive cost of moving from one set-up to another; provided closer supervision because the entire operation was within sight of the superintendent, and eliminated all delays common to longer hauls.

A bucket loader, equipped with a swivel spout, was installed to load the gravel from the stock-piles into batch boxes on industrial cars. The sand was shoveled into the boxes and the cement was dumped in by hand. Each train consisted of four cars or eight batches, and the complete loading time of the train averaged 4 minutes, or a batch every 34 seconds. A 3½-ton gasoline locomotive hauled the trains to the mixer where the batches were transferred by a boom mounted on the mixer. Only 1,890 ft. of track was necessary as the batches were hauled both ways from the stock-pile. At the loading plant a switch horse was used to handle the cars.

Physical conditions at different locations of the plant made necessary a change in the relative positions of the



PLANT LAYOUT FOR CHARGING BATCH BOXES WITH BUCKET LOADER

stock-piles and the cement platform but it was found very easy to accommodate this system of charging batch boxes to these changes. The equipment consisted of: one 14-E mixer with boom and bucket, mounted on caterpillars; three right-hand and three left-hand switches complete; 1,890 lin. ft. of track; 12 batch-box cars; 24 batch boxes; 2,000 lin. ft. of forms; one finishing machine; one sub-grader; four brakes for batch-box cars; one 3½-ton locomotive; one Barber-Greene loader; one Case road roller, and one 4½ x 5-in. Barnes pump. The total cost of this equipment was somewhat under 25,000.

A crew of 24 men handled all the work at the mixer, as follows: 3 men covering, etc., 1 man edger, 1 machine tamper engineer, 3 men on green concrete, 1 mixer engineer, 2 men on batch transfer, 4 form setters, 3 men light grading and subgrade machinery, 1 roller man, 2 drivers and teams, 1 mechanic, 1 pump man, and 1 foreman.

A total of 18 men handled the work at the material yard, as follows: 1 gasoline locomotive engineer, 1 brakeman, 1 loader operator, 2 loader helpers, 1 man at spout, 6 sand shovelers, 1 sand leveler, 3 cement men, 1 driver and team to build up stock-piles, and 1 switch horse and driver.

With this equipment an average of 768 sq.yd. or 142 cu.yd. was laid per 10-hour day, which means an average of one batch every 2 min. 17 sec. The maximum daily pour was 1,110 sq.yd. in 10 hours or 205 cu.yd., which is a batch every 1 min. 35 sec. On this work a 4-bag batch was used. The superintendent was Mr. J. W. Glidden. The contractors were the List & Hallett Cons. Co., Kansas City, Mo.

Chicago City Drawbridges: Correction

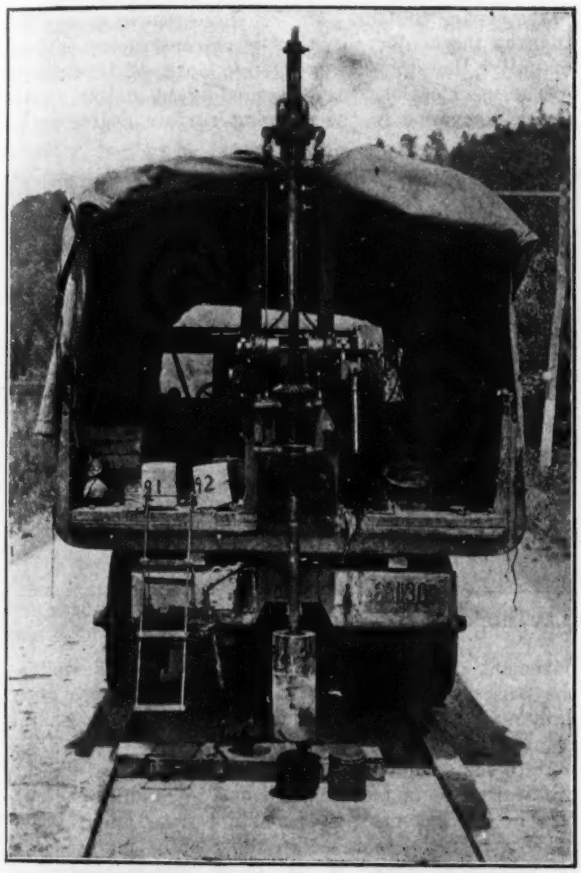
In a note on the highway drawbridges at Chicago, in *Engineering News-Record* of Nov. 17, 1921, p. 817, one was mentioned as being of the Strauss type, but there are two bridges of this type, at Polk St. and Jackson St. The latter was designed for the Sanitary District and not directly for the city. The Strauss patented girder system of trunnion support is represented in a number of other bridges, which however, are of the plain bascule type (counterweight rigidly attached to the moving leaf) and not of the parallelogram counterweight-linkage type (Strauss type).

Mobile Outfit Drills Cores from Concrete Roads

Pennsylvania State Highway Department Uses the Specimen so Obtained for Test Purposes

By D. E. Dunn and R. N. Coolidge
Ingersoll-Rand Co., New York

In obtaining for test purposes cores drilled from concrete pavements the Pennsylvania State Highway Department employees a mobile outfit comprising a 3-ton motor truck carrying the following equipment: (1) A Calyx core-drill (2) apparatus for determining bearing power of soil; (3) molds for concrete repair plugs; (4) bins for cement, sand and stone for repair plugs; (5) accessory tools for the work and repairs.



CORE DRILL ON TRUCK FOR PAVEMENT TESTING

The drill-head is a patented type especially designed for road-testing service, capable of taking cores from 2 to 10 in. in diameter from hard pavements. It is driven by belt from an 8-hp., two-cylinder, four-cycle, gasoline engine mounted in the forward end of the truck box with its own radiator and gasoline tank so as to be independent of the truck for power or supply. The drill is mounted flush with the end of the truck box, as shown in the photograph.

Back of the drill-head is a 130-gal. water tank. A hand force-pump is carried in case of an emergency, so that the tank can be refilled from creeks or rivers. Ordinarily not more than 3 gal. of water are used in drilling a core from an 8-in. pavement.

The drilling tool is a soft steel cylindrical bit with a flat or slightly rounded face rotated approximately 200 r.p.m. on a thin layer of steel shot fed through the bit and lying between the bit and the material to be drilled. Pressure is exerted on the bit as it rotates, breaking the shot into fine, sharp-edged pieces which partially imbed themselves in the face of the soft steel bit and are dragged along by it, thus abrading the material below. A slot is cut in the bit so as continually to work the steel shot to the cutting face and allow them to be crushed between the bit and the pavement. The shot are fed through the inside of the bit and tend to work toward the outside but are caught by the slot and again forced under the bit. This cycle repeats until the shot are ground to a fine powder light enough to be carried to the surface by the water.

Water is fed to the cutting face to cool the bit and wash the cuttings from the hole. As the drilling progresses a cylindrical ring is cut away and the core protrudes up inside the bit. When the hole has been drilled through the pavement, the bit is raised and the core lifted out and marked for future identification when shipped to the laboratory in Harrisburg where it is tested. For work of this sort a majority of states use a 7½-in. bit which takes a core approximately 6¼ in. in diameter.

In starting a hole on the flat road surface a guide board is used for centering and holding the bit in place. After penetrating ½ in. the bit follows the circular groove which it has cut. A ring of wet waste or rags wrapped around the bit and jammed between the board and the pavement has been found by some operators to be efficacious in starting the hole, as the waste holds the shot to the bit. Shot should be fed at frequent intervals and in small quantities. An ounce or two at a time is better than larger feedings at longer intervals. A 7½-in. bit will drill through an 8-in. concrete pavement in from 15 to 25 min. Three pounds of shot, which is inexpensive, is an ample allowance for each hole.

Care should be taken not to use too much water because the bit does its best work in a thin sludge of ground shot and rock, with sufficient water to carry to the surface only the finest rock.

When starting a trip, the core-drill crew is furnished a complete itinerary, with exact locations on the various roads to be drilled. In addition they are directed to drill cores from and take observations at any point where unusual conditions are indicated. They average three to four cores per mile of road, or approximately one every 1,500 ft., plus the extras for unusual conditions.

With a soil drill bit, in place of the concrete drill bit, a 1- or 2-ft. soil core, about 2½ in. in diameter, is removed. After the concrete core has been secured these soil samples are for laboratory study.

While traveling from one location to another concrete repair plugs are cast in special molds. The diameter of these is a little smaller than that of the bored hole. A 4 per cent solution of calcium chloride is used in the mix to accelerate the set. It is only a moment's work to place and grout one of these repair plugs with quick setting cement so that, when the testing outfit moves on to the next place the road is left in good condition.

The drilling outfit, which was developed by the Ingersoll-Rand Co., averages 16 cores per day.

12 Years' Experience with Bituminous Penetration Work on Kansas City Boulevards and Park Roads

A Review of Practice Since 1910 When Oil Binder Was First Tried on Macadam Roads—Asphalt Binder Now Favored—Maintenance Costs Given

By Fred Gableman
Engineer, Board of Park Commissioners, Kansas City, Mo.

SINCE the decision was reached in the spring of 1910 to adopt bituminous penetration methods for new construction and for maintenance and resurfacing of the original waterbound macadam pavements forming the 90-mile park drive and boulevard system of Kansas City, Mo., maintenance and repair costs, for the 12-year period, have averaged 4.385c. per square yard per year. Starting with the experimental application of a light residuum oil in 1906, materials and methods have been constantly studied and improved until the present practice, involving the use of an asphaltic binder by the penetration method, produces results which are believed to compare favorably with the best types of mixed bituminous construction.

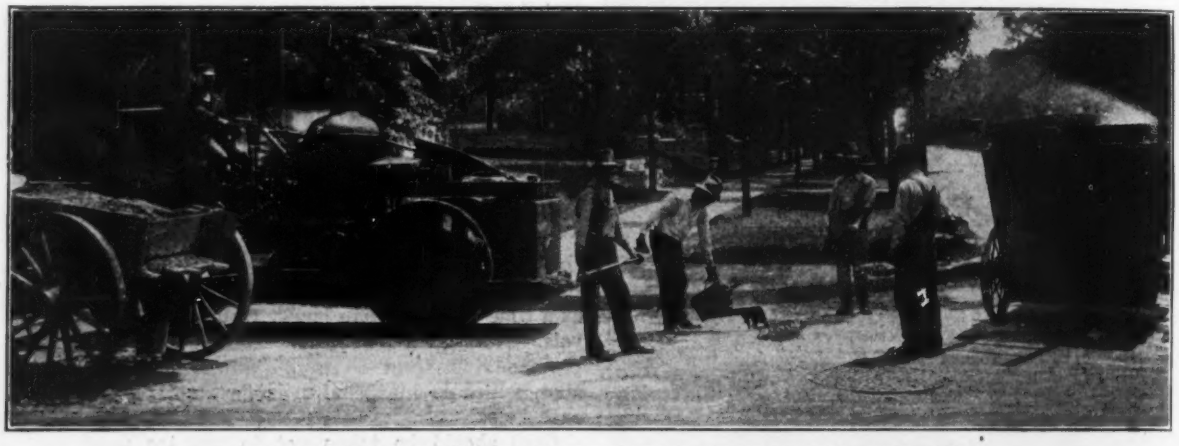
The standard width for the boulevards originally recommended by George E. Kessler, landscape architect, and adopted by the first Board of Park Commissioners in 1893, was 100 ft. with a central roadway 40 ft. wide, and parking 30 ft. wide on each side. The standard for construction was macadam pavement, 12 in. in depth, a concrete combined curb and gutter, and concrete sidewalk. Results have demonstrated the wisdom of that original plan. The only changes in construction have been the oiled surface and bituminous binder in the wearing surface of the pavement and an increased width of roadways, on account of the immense automobile traffic, of 50 ft. wide in the boulevards recently acquired and on older main arteries 50 and 60 ft. The commission is empowered to regulate the class of traffic on the boulevard system.

In constructing the boulevard a local limestone, somewhat soft for paving purposes, having a French coefficient wear of 6.3 to 8.3 was employed; its use was justified because of its availability. During the first few years, beginning in 1896, a three-course macadam pavement 13 in. thick, with a wearing course of harder material than the native limestone, was used to withstand the wear of steel-tired vehicles and shod horses.

As it was difficult to get shipments of granite or trap rock the specifications were changed in 1901 to use coarse bank gravel for the wearing surface, still retaining limestone for the second course and the base.

In 1900 the construction of the pavement within the parks began. As the traffic on these roadways was less than on the boulevards, they were constructed entirely of native limestone in two-course work, 12 in. thick.

The specifications were changed again in 1904 to use native limestone in the wearing surface course in all pavement construction on the boulevards as well as the park roads. All the roadways paved were given daily maintenance. This consisted of sweeping, making repairs, and daily sprinkling with water.



REPAIR CREW ON KANSAS CITY BOULEVARD, USING 500-GAL. KETTLE

With the advent of the automobile a new and difficult problem arose in maintenance and in binding the surface of the pavement, for constant wear and raveling made a material increase in the cost of maintenance. In September, 1906, W. H. Dunn, superintendent of parks, began experiments by sprinkling the pavements with a light residuum oil from the Kansas oil fields. The oil cost 77½c. per barrel of 42 gal. on the track. The cost of oiling the roadways for the fiscal year 1907 averaged $0.01055 per sq.yd., which covered labor, screenings and oil. The oil was applied by an ordinary street sprinkling wagon equipped with a tin trough perforated with ¼-in. holes about 1½ in. apart. To make a light dressing and absorb the excess oil limestone screenings were cast over the surface and rolled with a 6-ton roller. Two applications, one in the early summer and one in the early fall, were found sufficient to allay the dust for the entire season.

The oiling operation, continued in 1907 and 1908 produced a direct saving of 48 per cent in the sprink-

ling charge of oil as against water. The oil used wa the residuum crude oil obtained from the Kansas oil fields, testing between 19 deg. and 21 deg. Baumé at 60 deg. F., or an average specific gravity of 0.93. This has been the standard grade of oil used in the major portion of all oiling operations to the present time. During the summer this grade of oil has the right consistency to be applied without heating. The first application took about ½ gal. per sq.yd. and cost about 1½ c. per sq.yd., including labor, screenings and oil, with oil costing 80 c. per barrel of 42 gal. on the track. After the first application less oil was required.

This oil, having a paraffin base, left the pavement slippery for a few days. Having only a small asphalt content, there was very little binding quality in it. Experiments were made, using different grades of heavier oil with a larger percentage of asphalt, and also by mixing from 10 to 33⅓ per cent of asphalt with the residium oil, with the result that the slippery condition was largely eliminated, a better bond of the surface materials was made, and the treatment lasted much longer. These heavier grades and mixtures of oil, however, had to be heated before application.

The successive applications of oil and screenings and the dust gathered in the oiled surface, builds up a mat which, during the summer, is flexible and makes an ideal, smooth surface for travel. But during the winter, the oil gradually evaporating, the mat loses its life and becomes brittle. Towards spring, and especially after snows, when chains have to be used on the cars, the mat becomes broken and ragged. These broken patches leave places for the accumulation of water during the spring, causing a softening of the surface material and a rapid deterioration before it is warm enough to apply new oil. This condition first became noticeable in the spring of 1909 and continued as the mat became thicker. The experience with the oiling operation during the winter and spring months and the experiments with mixtures of oil and asphalt led to the conclusion that a bituminous binder should be used in the wearing surface course in the new construction work, and in repairs and resurfacing work on the old pavements.

Refined Tar Used

In the spring of 1910, the specifications were changed to use refined tar as a binder in the wearing surface. The base course, 7 in. in depth, was constructed of hand-broken stone or crusher-broken stone, as before. The top course, 5 in. in depth, was of crushed limestone from 1½ to 2½ in. in size, 60 to 75 per cent of which ranged from 2 to 2½ in. To this course, compacted by rolling, a dressing of refined tar was applied at a temperature of not less than 280 deg. F. in sufficient quantity to cover all parts of the pavement and until the tar appeared at the surface, which required not less than 1½ gal. per sq.yd. A covering of limestone grit to absorb the excess of tar and fill all voids was applied and rolled. It was found that some of the tar went into the base course and hence, in later work, an amount of binder rock and grit was rolled into the base course sufficient to fill the voids and thus keep the tar in the top course.

The tar used was Tarvia X. It was applied with a pressure-tank wagon equipped with a hose to distribute the material and a fire box under the tank. After the pavement was used a few days a light dressing of residuum oil was applied, to be absorbed by the dust and screenings left on the surface. This, with successive very light oil and screening dressings, built up a mat and weatherproofed the pavement so that there was no coking or disintegration of the tar in the surface. The first pavement of this construction is still in use, but the life has about gone out of the tar, as evidenced by the disintegration, pitting of the surface and repairs during the past year. The cost of this pavement averaged about $1.35 per sq.yd. by contract, with the stone costing $1.50 on the work, Tarvia 10c. a gallon, labor $2 and teams $4 a day of 8 hours.

Asphaltic Binder Adopted

In seeking a bituminous material with more resilience and lasting quality, that would not become brittle in winter nor bleed during summer, experiments, made with asphaltic cement of such consistency that it could be applied by the penetration method, led to the specification of this material in a contract let in the fall of 1911. This pavement was constructed in three-course work, the base course, 6 in. in depth, constructed as before, a second course, 4 in. in depth, constructed and

PRESSURE DISTRIBUTOR OILING 40-FT. BOULEVARD ROADWAY

water-bound the same as the top course in the water-bound macadam pavement, and then a 2-in. bituminous penetration wearing surface course, using Bermudez asphalt as the binder. This top course was constructed of crushed limestone ranging in size from 1 to 2½ in., the surface being left open and porous to permit the penetration of the bituminous binder. An application of not less than 1½ gal. of asphaltic cement was spread by hand, using a fan-shaped, lipped pouring can. By careful application the asphalt was spread uniformly and the quantity gaged closely by this method. The asphalt was heated on the work in 500-gal. kettles equipped with fire boxes and applied at a temperature of from 325 deg. to 350 deg. F. Immediately after the application of asphaltic cement a layer of limestone grit, ranging in size from ¼ to ¾ in. was spread to fill the voids, then rolled with a 7-ton roller. The surface was then swept clean of all dust and loose particles of macadam, and a second application of ½ to ¾ gal. of asphaltic cement per sq.yd. was spread, covered with a thin dressing of limestone grit, and rolled. This pavement has received a tremendous amount of mixed traffic

and is still in excellent shape, with scarcely any maintenance outside of the daily sweeping and cleaning.

The specifications for three-course bituminous macadam pavement, using asphaltic cement as a binder, were used until the spring of 1916, when alternate specifications were issued for the bituminous binder material, using either refined tar or asphaltic cement and giving the contractor the privilege of bidding on either one. The construction of the three-course pavement using asphaltic cement remained the same, except that the second course was rolled dry. The construction of the two-course pavement using refined tar remained the same as before, but as the top course, 5 in. in depth, was too thick for thorough penetration and had no seal coat, the specifications were changed in 1917 to make the construction and the amount of bitumen used the same in both pavements. Contracts were let for both classes of pavements at about the same price, and ranged from $1.13 to $1.53 per sq.yd., with asphaltic cement at $20 per ton, Tarvia at 10c. per gallon, stone $1.50 per cu.yd. delivered on the work, labor $2 and teams $4 per day of 8 hours.

Asphaltic Cement Preferred

By close observation and analysis of the two classes of pavements up to the present time, the asphaltic cement is found to give a better result than the refined tar, in that it is more resilient, has more lasting quality, withstands the extreme difference in temperatures between the winter and summer months without becoming so brittle in winter or bleeding so much in summer. During the past year these alternate specifications have been separated and entirely rewritten, the experience and best method of construction by the penetration method to date being embodied. The two specifications are exactly the same as to construction and amount of bitumen, the one specifying asphaltic cement and the other refined tar.

The cost, by contract, of the pavement with asphaltic cement as a binder for the past two years has averaged $2.26 per sq.yd., with asphalt at $30 per ton, stone $2.50 per cu.yd. delivered on the work, labor $4 per day of 8 hours, and $3 per hour for trucks of 4 and 5 tons—trucks being used almost entirely instead of teams.

Different brands of asphaltic cement have been used as a binder in the wearing surface of the pavement, but the major portion has been Texaco 96, which has run very uniform in its tests and given excellent results. The Bermudez asphalt used in the first contract of this class of pavement is a material whose higher price has barred it in competitive contract work.

This asphalt binder material is of such consistency that, under the constant rubber-tired traffic, it absorbs the dust and grit on the surface of the pavement and maintains a dustless pavement without the addition of the oil dressing necessary on the old waterbound pavements. Yet it is firm enough, with the elimination of the heavy trucks from the boulevards, and has bond enough with the native limestone to maintain a splendid pavement, needing scarcely any maintenance, outside of the daily sweeping and cleaning, since it was first used 10 years ago. With the penetration method it is found that the seal coat is necessary to give the surface a thorough bond.

The equipment for applying the asphalt consists of two 500-gal. portable kettles equipped with fire boxes, several fan-shaped, lipped pouring cans, two carts of 1-cu.yd. capacity, and one 7-ton roller, together with a force of 13 men. The two kettles are placed side by side on the pavement just back of the pouring; 1 man fires the kettles and 1 man feeds fresh asphalt into the kettles; 3 men fill the pouring cans and carry them to the man pouring asphalt; 1 skilled man pours the asphalt as the cans are handed him; 2 men load grit into the carts; 1 man tends to the horse and cart, taking it back and forth; 3 men spread the grit; and 1 man operates the rolling. The pouring extends to 75 ft. in front of the kettles on the first coating, when they are moved up to the edge of the pouring and 75 ft. poured in advance again. On the seal coat, one kettle at a time, alternately, is moved to 75 ft. in advance of the pouring and the pouring extended 75 ft. each way. With this outfit, 2,100 sq.yd. on the first application of 1¾ gal. per sq.yd. and 3,200 sq.yd. on the seal coat of ⅜ gal. per sq.yd. can be poured per day of 8 hours. A skilled man can spread the asphalt uniformly, which is essential with this class of pavement. This is somewhat of a crude method of application but admirable and economical results have been attained.

Simultaneously with the use of bitumen as a binder in construction work, asphalt began to be used as a binder in repair and resurfacing work, with the result that the old method of water-binding repairs was soon discarded. Various changes have resulted in the following equipment and method of repairs which have been used for the past five years.

Equipment and Methods for Repairs

The equipment for each park district consists of 250 and 500-gal. portable kettles, several pouring cans and fiber hand brooms, wagons and a 7-ton, tandem roller. The patrol outfit on starting out from the district operating yard, takes one wagon loaded with limestone binder rock and grit, one or two barrels of asphalt, and a 250-gal. kettle filled with two barrels of asphalt, hitched onto the rear of the wagon, two pouring cans, a fiber hand broom, and a 7-ton roller. The binder rock is from ¾ to 1¼ in. in size and the grit from ¼ to ¾ in. in size. The dust and loose particles are swept out of the ragged or pitted surface of the pavement, which is then filled with binder rock, rolled solid and uniform. Then a coating of hot asphalt is poured over the patch and covered with a dressing of grit sufficient to fill the voids, the grit broomed evenly over the patch and rolled again. The next time the patrol outfit goes over the boulevard, a light dressing of asphalt and screenings is spread over the larger patches and rolled again to give a seal coat and smooth surface for travel.

On more extensive repairs, a 500-gal. kettle and two wagons, one for grit and one for coarser rock, are used. The rock is deposited in piles on the side of the roadway by truck. The roadway is first swept with a rotary street-sweeping broom, the patches then swept out by hand and repairs made as last described.

On sections of boulevards where the surface of the old waterbound pavement has become so ragged and pitted that it needs repairs over a large portion of the pavement, a new bituminous wearing surface is constructed. On short sections this resurfacing is done by the repair crews in the maintenance work. On larger sections, where the old pavement has been in use from 10 to 15 years, the resurfacing is done by contract and the cost taxed against the abutting property.

Resurfacing work began in 1913 with the repair crew,

as an experiment. After the old surface had been removed a 2-in. bituminous macadam wearing surface was constructed in the same manner as for new construction. The seal coat was omitted at first, but it was found necessary the next season to go over this work again with a seal coat to give a smooth surface for travel. The success of these experiments was followed, in 1914, with a contract at 59½c. per sq.yd. to resurface, with a bituminous macadam including the seal coat, a heavily traveled boulevard 1 mile in length. The results have been excellent.

In all recent resurfacing work the old macadam surface is swept, then scarified to break the oil crust and loosen the macadam surface, the oil crust and dirt are raked off and the top course then rolled. This prepares the old surface to give a better bond between the old and new pavement. A 3-in. bituminous wearing surface is then constructed in the same manner as for new construction.

On resurfacing work now under construction, a pressure distributor is being used successfully to apply the asphalt. It has a 1,040-gal. tank mounted on a motor truck chassis and equipped with a fire box to maintain the heat after the asphalt is heated to the required temperature at the plant, and distributes the asphalt under a pressure of 65 lb. This contract was let at $1.37 per sq.yd., which includes the excavation and removal of about 3 in. of the old macadam surface—there being street-car tracks in the center—and the construction of the standard 3-in. bituminous macadam wearing surface.

With the advent of the oil and bituminous surface on the pavement and the rubber-tired vehicle, a flatter crown than originally provided was found advisable to relieve the slippery condition during wet weather. The crown has been changed to 9 in. on the 40-ft. roadways on grades less than 2 per cent, 8 in. on grades of 2 to 4 per cent, and 7 in. on grades of more than 4 per cent. On 50-ft. roadways a crown of 12, 11 and 10 in., and on 60-ft. roadways a crown of 15, 14 and 13 in. has been adopted on the corresponding grades, the parabola still being used for the curvature.

Maintenance Costs

The oiling operation on the old waterbound macadam pavement has been continued each year to keep life in the oil mat and to lay the dust. After the first few applications of oil it takes a very light dressing of oil on each application. This necessitates an equipment by which the amount of oil can be gaged to the fractional part of a gallon. In 1913, the old gravity oil sprinkler was replaced with a pressure distributor made in the Board of Park Commissioners' shops. This pressure oiler consists of a centrifugal pump attached to a steel oil tank mounted on the running gears of the former water sprinklers.

In oiling, only one-half of the roadway is treated at a time, leaving the other one-half open for traffic. The oiling is immediately followed up with a light dressing of limestone grit. The oil if left to penetrate into the surface for about three days before the other one-half of the roadway is oiled.

The average oiling is at the rate of 0.07 gal. per sq.yd. It cost in 1914, $0.004 per sq.yd. for one application or $0.00802 per square yard for the year which included cost of labor, limestone, grit and oil, the oil costing 2¾c. a gallon loaded into oil wagon. In 1920, it cost $0.00525 per square yard, only one application being made, with oil costing 6½c. per gallon. The slight difference in cost per square yard as against the greater difference per gallon for oil is due to the use of less oil.

As the success of the experiments became evident the penetration method was continued and perfected because the Park Department, with the limited funds at hand each year, was not justified in the purchase of the expensive machinery and equipment necessary for mixed bituminous concrete pavement, nor have the contractors under competitive bidding been justified in this purchase for the contract work on the boulevards for the amount of pavement constructed each year. With proper construction and proper consistency of the bituminous material, however, a bituminous penetration pavement has been obtained with the native limestone that is very close, if not the equal to, mixed bituminous concrete.

The success of a pavement is gaged by its original cost, its serviceability, its durability and its cost of maintenance. The following analysis of the cost of maintenance for a period of 20 years is for two boulevards that receive an average amount of travel.

Benton Boulevard through the South Park District, 2.14 miles in length, original cost of construction $1.65 per square yard.

Cleaning	$0.396 per sq.yd.
Sprinkling, oiling since 1906	0.283 per sq.yd.
Repairs	0.411 per sq.yd.
Average total cost of maintenance for the 20 years	$1.090 per sq.yd.

Armour Boulevard in the Westport Park District, 1.25 miles in length, original cost of construction $1.59 per square yard.

Cleaning	$0.407 per sq.yd.
Sprinkling, oiling since 1906	0.283 per sq.yd.
Repairs	0.367 per sq.yd.
Average total cost of maintenance for 20 years	$1.057 per sq.yd.

The figures show that the cost of maintenance on these two boulevards was only a little over 5c. per square yard per year for a 20-year period.

The average cost per square yard of the entire roadway system on the boulevards and parks for the past 12 years has been $0.04385 per square yard per year, distributed as follows:

Cleaning	$0.01401 per sq.yd.
Oiling	0.01320 per sq.yd.
Repairs	0.01664 per sq.yd.
Total cost per year for 12 years	$0.04385 per sq.yd.

Truck Overloads Checked in New Jersey

Twenty-five per cent of the motor trucks weighed on New Jersey's new roadside scales at East Paterson, Newark, Trenton and Camden are found to be overloaded from 1,000 to 19,000 lb. The average overload, according to data from the Motor Vehicle Department, ranges from 3 to 5 tons.

Many trucks are overloaded 6 and 7 tons. In some instances trucks are so overloaded that the springs are pressed down, allowing the load to rest on the axle. the tires being flattened out so that the entire unsprung load is transmitted through the flanges of the wheels to the road.

Many cases have been found where owners have mis-stated the capacity of their trucks in order to secure lower license fees. The weighing at irregular intervals at various points is causing licenses for greater loads to be taken out, thereby increasing the revenue to the State.

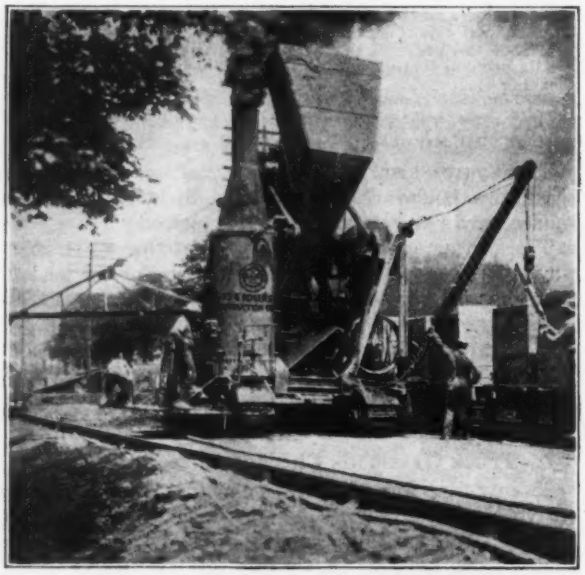
In addition to those mentioned above, scales will be built at Phillipsburg and Jersey City, with capacities of 60 tons. These scales were secured from surplus war materials of the United States Government.

Special Methods in Using Slag in Concrete Roads

Aggregate Proportioning and Handling and Finishing Methods Different for Slag Concrete —Surplus Train Service Profitable

SLAG concrete was successfully used last year on about 18 miles of heavy-section concrete road between Cleveland and Akron, Ohio. This is perhaps the most extensive use of slag in trunk road construction of which there is record. It called for somewhat different methods, particularly in finishing the slab, and for an adjustment by trial of the proportions to obtain the most easily worked mixture. These modifications in methods, an over-equipped haulage system, the development of a subgrade finisher and a steadily good progress, lend interest to a substantially straightforward concrete road building operation.

There is a heavy motor truck traffic between Cleveland and Akron and the new road is intended as a trunk line for this traffic. It is concrete, 18 ft. 4 in. wide, 10 in. thick at the center and 8 in. thick at the edges, with a reinforcement of 32-lb. mesh, 6 in. above the bottom of the slab. There will be 6-ft. shoulders. The ditches



PAVING OUTFIT FOR SLAG CONCRETE ROAD

have slopes of 1 on 1½. Slag for concrete was the choice of the contractor, it being at his option to choose that material subject to specifications. Nominal proportions of 1:1½:3 were specified, but the proportions actually used were more nearly 1:1¾:2¾.

Central proportioning and batch box haulage by industrial railway to a 21-cu.ft. paving mixer and finishing machine, was the general method adopted by the contractor. An average progress of 450 ft. a day, for the season, was made, and on several occasions the day's work was over 700 ft.

A hilly route made the hauling of the dry batches one of the largest problems of the work. There was hardly a level stretch in the 17½ miles of road constructed. The maximum grade was 7 per cent and there were several grades of from 3 to 5 per cent. On the heavy grades train lengths had to be cut down and helper engines used. With 6-ton gasoline engines, an eleven-car train could be handled on grades up to 3 per cent and then the train had to be cut to eight cars. For grades exceeding 3½ per cent a helper engine was required to handle an eight-car train. Without help, a 6-ton gasoline, generally speaking, was limited to a 3 per cent grade with an eight-car train.

There was a rather mixed equipment of cars—many makes with all sorts of journals—but all cars showed excessive axle breakage charged to crystallization. With the many different cars, the trains were also hard to pull. Nine locomotives, three 8-ton steam, one 8-ton gasoline and five 6-ton gasoline, were employed. The 8-ton gasoline was purchased so late in the season that it is hardly correct to count it in the regular outfit and also one of the steam locomotives was so decrepit that it counted for only about half a locomotive. With seven and a fraction locomotives capable of full service and a maximum haul of seven miles, the industrial railway was unusually high powered. Generally about two locomotives were stationed on hills as helpers which left five to haul trains, an unusual number for serving one paver and one finisher. They, however, kept the paver going which, with eleven miles of road to build with one outfit in one season, was the big object.

Track Maintenance

As the eight-ton steam locomotives were more destructive to track than the gasoline locomotives, track maintenance was cut down by hauling half way out with them and then picking up the trains with the 6-ton gasoline engines. An eight-ton steam dinkey, it was found, was a destructive load under such track conditions as the shoulder of a clay road grade made possible. The track used was 24-in. gage with 28-lb. rail spiked to wood ties, which is much heavier construction than is usual. Incidentally the wood ties were found to give a far more sturdy track structure than steel ties. About 6 x 6 in. in section, the wood ties were stronger as girders than steel and when not uniformly supported, carried the rails without bending and thus pinching together the gage. Built in 15-ft. sections, about 80 sections, or 1,200 ft., of track could be shifted daily with six men, but eight men gave better results, as a 15-ft. wood-tie section was rather heavy for six men.

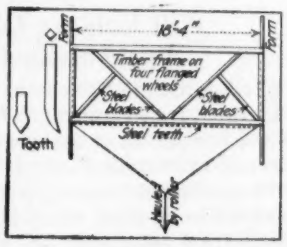
Simple proportioning plant arrangements were possible with the over equipped haulage outfit. Two double-bin charging outfits proportioned all the batches. Kept filled with slag and sand from stock piles, the bins discharged together through measuring chutes into a hopper, thus giving the materials a preliminary mix, which was emptied by gate into the batch box. With plenty of cars this simple outfit met the requirements. Cement was charged by hand emptying the bags through traps in a platform under which the train passed. With trains to spare, rapid charging to reduce terminal delays was not important and the proportioning plant was reduced to its simplest elements.

Experience in unloading and charging the slag aggregate disclosed (1) that it was much more easily handled with a clamshell than stone or gravel and (2) that its movement when being gated out of bins and run through chutes was much more sluggish than stone or gravel. Arching in the bins was more common with slag. In proportioning plant operations,

therefore, experience advises bin construction which reduces the opportunities for arching; good size discharge openings with gates which open quickly and cleanly, and wide, open chutes.

A standard 21 cu.ft. paving mixer and a finishing machine, with supplementary hand finishing tools, put down the paving slab. A one-minute mix was required but the consistency was left almost to the discretion of the contractor who however had to keep to a fairly dry concrete because of the grades. He also had to place the concrete in two layers to provide for the reinforcing mesh 6 in. above the bottom.

Ordinary procedure was followed in batch box charging and in mixing and placing. To place the concrete in two layers the finishing machine was equipped with two strike boards, the extra one designed to drop down inside the forms and smooth the bottom 6-in. layer to receive the reinforcement, which, incidentally, was ordered and shipped in flat sheets cut to slab width. Sheets instead of rolls were preferred, as precut sheets eliminated straightening and cutting in the field and were generally more smooth and better fitting than field prepared sheets. With the reinforcement down, the top layer of concrete was placed and shaped by the regulation crowned strikeboard of the finishing machine.



NEW FORM OF SUBGRADE FINISHING MACHINE

Succeeding operations of slab construction were modified by the slag ingredient of the concrete. Slag is light, with always a tendency to float, particularly in a wet mixture, and machine tamping brought it to the surface so that machine belting would not produce a smooth surface. In fact the action of the belt seemed rather to aggravate the roughness by "dragging" the surface fragments of slag. To meet the conditions the belt was removed from the machine which then only struck off and tamped the slab. The hand finishing process worked out was to "belt" the slab with a flexible board and then finish with a float.

With the slag brought well to the surface by the tamping it was found that a finishing operation which would press the slag down and hold it until it stayed down, due to the mortar overflowing, was essential. A 12 x ½ in. board laid flat across the slab like a belt was the device adopted to do the work required. By shuttling the board crosswise of the slab and gradually advancing it 12 in. and then letting it stand a minute or so the slag was pressed down and held until it locked. The finishing of the green concrete, was, then, a series of zig-zag advances of the board with alternating periods of rest. When the concrete had dried out it was hand floated with a long handle steel float. Curing was affected by covering the slab with canvas tents on wheels, five or six coupled tents being pulled by the finishing machine, and then sprinkling the surface after the tents had been hauled ahead.

Slag concrete not only required the special finishing methods described, but its proportions had to be worked out by trial to get a mixture reasonably easy to work at all. The nominal proportions were 1:1½:3 but this gave too harsh a mixture to be finished well or even to mix smoothly. As the result of trial 1:1¾:2¾ mixture was adopted. There was no difficulty with this mixture following the methods described.

With a clay soil, very hard when dry, it was found that finishing the subgrade required a more positive acting and stronger tool than the regulation subgrader. A machine of the general form illustrated was developed and met the conditions. The frame rides on four flanged wheels from which it can be lowered so that teeth and blades engage the soil or raised to clear the ground. The innovation from standard subgraders is the row of spoon-shaped teeth which loosen the packed earth.

The contractors for the work described were the Bates & Rogers Construction Co., Chicago, Ill., and it was built under the direction of the Ohio Department of Highways, E. E. Blosser, state highway engineer.

Culvert Pipe Load Investigations

EXPERIMENTS on the weight transmitted to culvert pipe under various depths of fill indicate that the load may be greater or less than the prism immediately above the pipe, depending on the manner in which the pipe is laid. If the pipe is laid in the ground the load may be as much as 1¾ times the weight of the prism. If it is laid in a trench in material well compacted the transmitted load may be even less than the prism. In general these are the findings deduced from uncompleted experiments recently reported to the members of the Joint Concrete Culvert Pipe Committee by Dean Anson Marston, Iowa State College. Work along this line has been carried on since 1915 but was interrupted during the war.

The experiments were made with a 20-ft. length of 42-in. pipe divided into 2 ft. sections each of which rested on an independent weighing device. A 20-ft. embankment was gradually built up with a sandy loam soil, weighing 96 lb. per cu.ft., readings being taken at frequent intervals of height at each of which a truck of 10-ton total load was passed over each 2-ft. section. Similarly, the loads were measured when the embankment was removed. The 20-ft. fill was left on during the winter for observation during various conditions of temperature and rainfall.

Under the above conditions the following formula for the load on pipes seems to have been established:

$$W = KwD_oH$$

in which

W = actual pressure on culvert, in lb. per lin.ft.
K = a constant (for the 1919-20 tests, $K = 1.75$ approximately).
w = weight of embankment material, in lb. per cu.ft.
D_o = outside diameter-of pipe culvert, in feet.
H = height of embankment above top of culvert pipe, in feet.

The safe maximum loads imposed on pipe culverts by sandy loam top soil would probably be $W = 200\ D_oH$, which indicates a straight-line law. It is not certain that the constant K is the same for all diameters and it may be materially affected by the height which the culvert projects above the surface of firm ground adjacent and by the comparative rigidity of the foundation and surface adjacent to the culvert.

Concentrated load effects are small, according to the 1920 tests, when the surface of the embankment was more than 4 ft. above the top of the pipe. For heights less than 2 ft. the full weight is transmitted.

The strength of pipes as determined by different methods of bedding are as follows: (See *Bulletins* 47 and 57, Iowa State Engineering Experiment Station.)

(1) "Impermissible pipe laying," where the pipe rests on the flat bottom of a trench without special bedding fit, causes a reduction of at least 20 per cent below ordinary supporting strength. (2) "Ordinary pipe laying," where the bottom is rounded for 60 to 90 deg. of the lower circumference, the ordinary supporting strength is about equal to that developed in the laboratory by the use of "standard sand bearings" as prescribed by the standard specifications. This construction should carry 8 ft. of embankment and all ordinary concentrated loads on highways. (3) "First class pipe laying," where the under side of the pipe is thoroughly bedded for at least half of the circumference, the supporting strength is 20 per cent greater than in (2) above. (4) "Concrete beddings" of considerable thickness under the pipe,, reaching to one-third its height increases the strength 80 per cent above the ordinary bedding. (5) For superior strengths the pipe may be used as an interior form for the surrounding concrete, the strength depending on the design. Detailed results of the various tests will be given in a forthcoming *Bulletin* of the Iowa Engineering Experiment Station.

Car Operation Waste Eliminated by Use of Containers

LOSS of mail by theft, less expense in mail handling, quicker transfer at important gateway points, and increase in load per car, are some of the advantages to be gained in the use of container cars, pointed out by Walter C. Sanders, of the equipment engineering department of the New York Central lines, before the members of the American Society of Mechanical Engineers at their annual meeting held recently in New York City.

Mr. Sanders reviewed the work that the New York Central has already done in the matter of transportation of mails and freight with the use of container cars, and outlined what is being attempted in the construction of even larger cars than are now in use. Reference to construction and operation of container cars may be found in *Engineering News-Record*, March 31, 1921, p. 557.

A summary of the advantages of the container car system of transportation, both for mail and for merchandise, Mr. Sanders gave as follows:

It will furnish a means of expediting delivery of less-than-carload lots of commodities by eliminating the time and expense of rehandling, checking and trucking.

It will eliminate costly crating and packing:

The immediate loading and unloading of containers at terminal points eliminates the item of demurrage, at the same time promptly releasing rolling stock, clearing the yards of cars and reducing congestion.

It will eliminate the piece-meal loading of cars at railway sidings in exposure to all sorts of weather.

It will tend to keep the car moving at all times, making possible double the mileage as made now by the ordinary type of rolling stock;

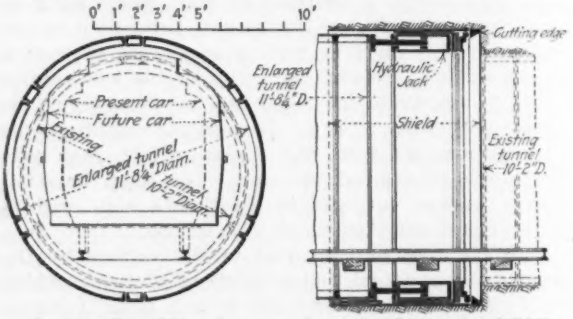
Containers are fire and weather-proof and also burglar-proof in that they cannot be opened while on the car or while being transferred by handling device to and from car.

The New York Central is now having constructed three new mail-type container cars that will carry eight containers of a new and improved design, the outside measurements being: Length, 7 ft. 2½ in.; width, 9 ft. 3½ in.; clear height, 8 ft. 2 in.; with a 5-ft. 9-in. x 3-ft. 6-in. door on the length side of the container. The cubic capacity will be 438 ft., light weight, 3,000 lb., and capacity, 7,000 lb.

Tests conducted on the New York Central during the past few months show that the express type of container car can be emptied of its nine containers by an ordinary crane in 21 minutes, reloaded with other containers and put back in operation in about the same amount of time. The tests were made with an ordinary moving track crane, since no special devices have as yet been constructed for use in handling containers.

Will Enlarge London Tunnel by Shield Method Under Traffic

ENLARGEMENT of the City & South London Ry. rapid-transit tunnel in London to take larger rolling stock and permit of exchange of traffic with other rapid-transit railways is likely to be started soon under a plan of procedure developed by Mott & Hay, engineers. The method to be used, which is of exceptional interest, has been tried out during the past summer on a length of about 200 yds. near Stockwell Station and proved successful. The City & South London tunnel is the oldest of the London deep rapid-transit lines, having been built between 1886 and 1890 by J. H. Greathead. Its diameter is only 10 ft. 2 in. inside of the cast-iron lining, and in consequence the cars are very small and the clearances close. The diameter is to be increased by 18¼ in., utilizing the segments of the existing lining supplemented by short intermediate segments to make



ENLARGEMENT OF C. & S. L. TUNNEL
Broken line, present section; full line, enlarged section.

up the increased circumference. This rearrangement of segments is shown in the cross-section herewith. The change is to be made under protection of a tunneling shield as indicated by longitudinal section. The shield will permit the present trains of the line to pass through it, and the track is to be carried through old tunnel, shield, and new tunnel uninterruptedly. Actual work in advancing the shield, excavating the ground, and placing the lining of the enlarged tunnel can, of course, proceed only when trains are not running, which means during the early morning hours. Conditions normally will give about four hours working time per day, in which time two rings, or a 40-in. length of the tunnel, should be reconstructed. When completed, the improvement is expected to double the carrying capacity of the line by permitting traffic interchange and the use of larger rolling stock.

What 1921 Developed in Paved Road Design

Heavier and More Reinforcement in Concrete Slabs—Macadam Roads Widened by Concrete Borders—Split Slabs Used in the Wider Concrete Roads

THE specific developments in concrete road construction in 1921 were: Increased resort to reinforcement; extension of the service of macadam roads by border strips of concrete, and the design of pavement slabs with longitudinal joints or planes of weakness. In general, the scientific design of paved roads was brought closer to realization by Federal and State investigations of impact loads and of subgrade action. With the close of the year highway engineers could undertake to design pavements with some knowledge of load stresses and of the support rendered by subgrades.

An increased tendency to place a sturdy steel structure within the concrete slab was evidenced, in states where concrete roads are universally reinforced, by increasing the weight of the reinforcement and by developing systems of bar reinforcement or by using bars locally to strengthen light mesh reinforcement. In states where plain concrete road construction is the practice, steel has been introduced to resist displacement by shearing action or for bonding purposes, where cracks develop or longitudinal joints are introduced.

Trend in Reinforcement Use

An increase of the weight of the steel was observable in all states where reinforcing is general. Pennsylvania nowhere used less than 0.56 lb. per square foot of steel fabric with ¾-in. bars across the slab on both sides of joints. In New York some 0.3-lb. mesh was employed, but commonly in such cases L-bars were added at the four corners of the 33-ft. slabs, and, for the later designs of the year, full bar reinforcement, weighing 0.6 lb. per foot, was adopted. With heavier reinforcement, bar systems are made possible as well as steel fabric, and competition in price is extended.

Toward the close of the year, the talk of the department engineers in both New York and Pennsylvania, ran in favor of still heavier steel. No one had, however, screwed up courage to go the limit and ask for the 1¼ lb. per square foot needed if a truly reinforced pavement for truck traffic is to be expected. In other eastern states no greater tendency to add weight to the steel has been exhibited and western states generally have not passed the chicken fence stage of reinforcement.

To highway engineers who have large mileages of macadam, either waterbound or bituminous, the widening of the road by border strips of concrete is in many respects the most interesting development of the year. Practice in Maryland best exemplifies the idea. Here 3-ft. strips of concrete were added to the sides of the old macadam. Widening was the primary object of these strips, but they serve the supplementary purpose of curbs. These curbs, it was found, reduced raveling of the macadam at the edges and added to the service of the pavement

In New York State, in place of the narrow strips used in Maryland, single-track pavements eight and nine feet wide, are employed relegating the macadam part to the subordinate service of giving passing room for vehicles. This is more nearly a macadam reconstruction practice than a macadam widening practice, as in Maryland. The underlying purpose in both practices is to prolong the service of old macadam roads. They are, as far as a short experience discloses, giving this longer life.

Technically, the most interesting development of the year is undoubtedly pavement constructed as two slabs, edge to edge. In some designs a constructed joint separates the slabs; in other designs the separation is marked only by the construction joint formed by building one slab before the other, and in still other designs there is no physical separation, but a plane of weakness induced by a groove in the slab top and no reinforcement across, or in, a center zone under this groove. In the last design as in the first, the slabs are absolutely separate in structure.

Besides the joint type differences enumerated, there are differences in practice in constructing joints of the same type. In Illinois a corrugated iron plate forms the separating element and short dowel bars span the joint and in Massachusetts the joint is the ordinary bituminous fabric construction. New York has used a plain construction joint formed by building one slab against the other or else the plane of weakness formed by grooving the slab top along the center line and omitting reinforcement across the center. At the close of the year practice in New York appeared to be somewhat settled on establishing a monolithic slab, with a plane of weakness, as the standard construction.

It is the growing opinion of those who have had experience with the divided slab structure that it meets better the cracking hazard from warping of the slab and from subgrade changes. It is held to be an advantage also in construction and in handling and locating reinforcement, if the two slabs are constructed separately. With only half of the road occupied by construction operations traffic is only slightly interfered with and detouring, ordinarily, ceases to be a problem.

Other Innovations

Besides the outstanding developments described two or three isolated innovations in concrete road design attract attention. Possibly the most notable of these is the Wyoming experiment in precast slab road using slabs about 9 x 10 ft. The results are said by the state highway department to have been satisfactory both in construction and in service and some 16 miles more of precast slab road are planned for 1922. In Arizona, also a far-western state, about 150 miles of concrete road have been built with edges 3 in. thicker than the center. Also it should not be overlooked that the Bureau of Public Roads has built as an experiment a slab and girder road and is studying the possibilities of this type with much hope that it will prove practicable.

No striking developments of the design of other than concrete roads were recorded in 1921. There was shown a disposition to increase present standard widths and to thicken gravel surfaces. Where penetration macadam was constructed there was evident a pronounced disposition to thicken the base. Other changes were minor.

High above all the things that have been mentioned, in its promise that thought in paved road design may be kept virile, stands the research work of the Bureau of Public Roads and of leading state highway departments. This is the truly creative accomplishment in highway designing in 1921.

The Status of Highway Research

Major Developments in the Field of Investigation Cited—Census of Research Planned

By W. K. Hatt
Director, Advisory Board on Highway Research, National Research Council, Washington, D. C.

IT IS ONLY through scientific research that the operations of Federal, state and county road officials, charged with the responsibility for the wise expenditure of vast public funds, can be adjusted in some reasonable measure to their responsibilities. The information must be gathered together in a systematic and disinterested way so that money spent on highway construction that is neither too cheap nor too expensive may represent capital wisely invested rather than capital consumed. These roads should be suitable to the physics of the situation, furnish economical transport and be adjusted to the present and future resources of the community.

The Advisory Board on Highway Research of the National Research Council is engaged in organizing committees to cover the various fields, including economics, operation, design of road, design of vehicle and construction. The object of the advisory board is to prepare a comprehensive program of highway research, to stimulate and support research therein, and to co-ordinate the efforts of the workers. The need is great and the economies in sight run high.

The advisory board has already established three main committees for the assemblage and study of research data. Committee 1, under Prof. T. R. Agg, of Iowa State College, covers Economics of Highway Improvements. Committee 2, on Design of Highways, under A. T. Goldbeck, of the U. S. Bureau of Public Roads, covers Mechanics of Road Design. Committee 3, under H. S. Mattimore, testing engineer, Pennsylvania State Highway Department, covers Character and Use of Road Materials. Other committees are in process of formation.

Plans are under way to begin immediately a census of highway research work, now complete or current, and to establish a highway research information service by which the results of research may be made immediately available to those officials who are constantly making decisions involving the expenditure of large sums of money.

Activities in Highway Research

At this early stage of highway research considerable boldness is required to describe the indications of researches or to determine those that are most important. At the suggestion of *Engineering News-Record*, however, the writer will do his best to summarize the present condition of the several departments of research, as presented in a chart published in this journal, Sept. 15, 1921, p. 450.

Relation of Highway to Other Transport—Freight is finding its way through new channels. Are they economical channels? Of the total freight between Bakersfield and Los Angeles, California, 63 per cent is carried over the well-known Ridge Highway rather than by the Southern Pacific Railway. Are these truck lines really profitable? The abandonment by the Boston & Maine R.R. of two branch lines in New Hampshire because of highway traffic is an indication of the growing use of the automobile for short hauls. It is, therefore, of increasing importance that the data underlying the economic disposition of traffic among the various agencies of transportation be obtained by trained research workers. Only in this way can an overhead view be obtained of the relation of highway transport to other existing agencies. The wealth of the nation which is now available for transport is limited and an over-extension of highway transport may not only starve other agencies but may wipe out existing assets. The U. S. Chamber of Commerce estimates that the investment in highway transport is equal to that in railway transport, both computed outside the boundaries of cities.

Economics—There is an important service to be rendered by the highway engineer in so locating his road that the cost of operation will be reduced, these costs including fixed charges, depreciation, operating costs, including maintenance of the vehicle as well as the road. It is hoped that within the course of a year the cost of operation of vehicles, as determined by location of highways, will be fairly well determined. Prof. Agg has accumulated a large amount of data in connection with the work of the experiment station of Iowa State College, and he is also directing work in New England in which Harvard Unversity, Yale University, Massachusetts Institute of Technology, the U. S. Bureau of Public Roads, U. S. Army, Society of Automotive Engineers and the highway commissions of Massachusetts and Connecticut are co-operating.

Traffic Studies

There is a live interest in traffic studies which have been planned in a large number of states. Something more than the count of vehicles is necessary. The proportion of truck traffic and the weight of the vehicles should be known in order that some estimate may be made of the proportion of the maintenance costs chargeable to truck traffic. It has been estimated that $12 are spent on the vehicle each year where $1 is spent on the road.

One of the most complete traffic studies is that now under way in the state of Connecticut (see p. 48 of this issue) in which not only the mechanical features of the traffic but the commodity value, the origin and destination are recorded.

One of the most complete studies of the laws of development of traffic is now about complete under the direction of Dean A. N. Johnson of the University of Maryland. Drafts have been drawn showing the development of traffic during four years from 150 stations on the highway system of Maryland.

J. H. Mullen, state highway engineer of Minnesota, estimates that one-third of the traffic on the main lines is regular business traffic which may be expected to appear on these lines and that the excess will be dispersed on other main lines when the latter are built. He shows that in Minnesota the proportion in truck traffic is increasing three to four times as fast as the increase in proporton to automobile traffic. He estimates that on a gravel road 20 trucks a day are as destructive as 300 automobiles.

In Rhode Island during six years the automobile traffic has increased 102 per cent whereas the truck traffic has increased 650 per cent.

The most important sources of information on traffic are the states of Connecticut under Commissioner Charles J. Bennett, the state of Maryland under the direcon of Dean A. N. Johnson, the state of Iowa under Prof. T. R. Agg, the state of Minnesota under J. H. Mullen.

state highway engineer, and the information gathered during the recent studies of highways in California by the U. S. Bureau of Public Roads.

The state highway departments take on very largely the aspect of traffic departments in our industrial centers. A striking suggestion by Mr. Mullen, of Minnesota, is that the speed on heavy passenger lines be limited to 40 miles per hour at the maximum and 25 miles per hour as a minimum between the hours of 8 a.m. and 8 p.m. This will force the truck traffic to the use of the roads in the night time.

The art of signaling highways needs study, and the recent paper by A. R. Hirst, state highway engineer of Wisconsin, indicates the growing importance of this portion of the operating field.

Maintenance costs, one of the most important elements entering into the economics of highway construction, have in the past not been properly allocated. A great deal of experimentation and research is needed to fix upon the correct theory of maintenance of the various classes of roads. An interesting experiment in the maintenance of a gravel road under the direction of A. R. Hirst of Wisconsin shows the possibility of useful research in this line.

The Michigan State Highway Department has under way an experiment to determine the efficiency of various dust preventatives.

Subsoil Research

A large volume of research is directed to the study of sub-soils, particularly that element of the soil which determines its properties and to the treatment of subsoils by drainage and the admixture of chemical additions. The most important agencies in this field are the Bureau of Public Roads, the Sub-soil Committee under the chairmanship of General T. C. Dupont, organized first as a committee of the now inactive Federal Highway Council, the work by Prof. Eno of the Ohio State University, by Clifford Older of the Illinois State Highway Department, and by the University of California. These researches include the mechanical and ultimate analysis of soils, instruments for determining bearing power and study of water movement and consequent volume changes. In California the soil is improved by mixing in coarse aggregate. In some states a layer of tarred paper is placed on the sub-soil to prevent the entrance and egress of water which it is thought results in harmful volume changes of the concrete slab. When the studies under way are complete we should have within the year a fairly satisfactory account of the action of sub-soils, the means of testing them and the implication which the data carry into the field of design. It is Mr. Older's observation that in the case of the soils of Illinois there is practically no supporting power under expected conditions, and that therefore the concrete slab must be designed as an overhanging cantilever with the load at the corner of the slab. The Bureau of Public Roads has treated some sub-soils by the admixture of additional materials such as portland cement which apparently renders a plastic clay granular in its nature and destroys the plasticity. Experiments are under way by the California state commission on various methods of treating adobe sub-soils.

The width of surfacing is closely related to the findings of traffic studies and the habits of drivers in effecting safety. Multiples of ten feet are advocated by some. The Committee on Standards of the American Association of State Highway Officials will be the source of authority upon questions of this kind.

As concerns the design of stiff slabs under a specified loading we have an interesting field of scientific experimentation on a large scale. Some of the experimental roads may be listed as follows:

(1) Bates experimental road, 2 miles long, built by the Illinois Highway Commission under the direction of Clifford Older, contains brick surface on concrete slabs of various mixtures and differently reinforced. All of this is described in the *Engineering News-Record* of Aug. 18, 1921, p. 274. Complete scientific observations on sub-grade conditions and volume changes in slabs are supposed to be applied in the spring of 1922, accompanying laboratory tests of the ability of plain concrete to withstand repeated stresses.

(2) Test road, 1,500 ft. long, oval in shape, built by the Columbia Steel Co. at Pittsburg, Cal., under the engineering direction of Messrs. Leonard and Aldrich of San Francisco, and with the co-operation of the Bureau of Public Roads and the California Highway Commission. (See *Engineering News-Record*, Dec. 29, 1921, p. 1048.

(3) Reinforced-concrete precast slab road built in 1920 at Caspar, Wyo., 2,400 ft. long, in desert. Units are 8 ft. long, 9 ft. wide and 6 in. thick.

(4) Experimental concrete highway 2 miles long under construction in Alexandria County, Virginia, under the direction of the U. S. Bureau of Public Roads. Sections of varying thickness and shape, with varying reinforcement. Preliminary scientific measurements. Normal farm traffic.

(5) Experimental road, circular track, concrete base and bituminous top, built by the U. S. Bureau of Public Roads at the Experimental Farm, Virginia. Various combinations of bituminous tops are to be tested under the action of a truck which is guided automatically.

There are several roads built containing variations in aggregate or reinforcing as part of state systems, the data and desecription of which are not now available.

We have also the remarkable impact investigations conducted by the Bureau of Public Roads under Mr. Goldbeck, at the Experimental Farm across the river from Washington. These researches have been reported quite completely in the technical press and need not be described.

Slab Reinforcement

The last word has not yet been said on the policy of reinforcing concrete roads. One theory demands a thick, heavy slab massive enough to withstand such loads as are found in the state of Washington, viz. 20 tons of logs. Another theory proposes a thin flexible slab which will deform under a load or under the action of frost and be brought back to its primitive shape by the working of the reinforcing steel. No doubt the adjustment in this respect would be determined by the conditions of supply of materials and by a comparison of the maintenance costs of heavy concrete roads and thinner reinforced roads. Those who are designing experimental roads should have this element of research in mind. The amount of reinforcing generally used is only sufficient to hold together the broken sections of the concrete slab. Research is needed to determine the amount of reinforcing which will be really effective under the different regional conditions of this country.

Restrictive legislation on truck loads may result in a

redesign of vehicles with new tire equipment or new relations of sprung and unsprung weight or multiple axles to carry gross loads over the highways with less destruction of the road. The recently organized committee composed of representatives of the Society of Automotive Engineers and highway engineers will consider the mutual relations of the vehicle to the road. The highway engineer also, in conjunction with the automotive engineer, must conduct research upon the effect of the various road surfaces upon the operating cost including gasoline consumption and tire wear, and the operating departments must also consider the road surface and alignment in relation to the statistics of accidents. All of these efforts only come from a determined organized program of research. Roads must also be evaluated from the standpoint of tractive effort and safety. A reliable judgment on many of these issues cannot be reached until adequate and properly analyzed maintenance data are available.

One of the outstanding problems in the construction field in the sub-division of material, is the cause of surface waving, both in gravel and bituminous roads. Research is needed to determine the cause and remedy. H. S. Mattimore of the Pennsylvania State Highway Department and Major F. S. Besson, of the District of Columbia, are active in research upon the cause of waves in asphalt surfaces. The Bureau of Public Roads is making a special study of the corrugations of gravel roads.

A research into the efficiency of the operations of concrete mixers is much needed and also a further study of the product of central mixing plants.

The excellent survey of road materials by which bidders on highway construction may know the available sources of acceptable material, quarry conditions and freight rates, such as are conducted by Mr. Mattimore, of the Pennsylvania State Commission, result in an easily computable saving of money to the states. Mr. I. W. Crum, testing engineer of the Iowa Highway Commission, and Professor M. O. Withey of the University of Wisconsin have given special attention to the use of available aggregates. The Kansas State Agricultural College and the Texas Highway Commission are both active in the field of development of materials of construction.

A little later the National Research Council expects to issue the results of a census of research in which the many valuable studies under way in the experimental stations of the various state universities will be listed and described. It is difficult to mention a few of these investigations in a paper of this kind without doing injustice to the large number of devoted research engineers.

New Railway Bridge Specifications Published in Tentative Form

Specifications for railway bridges have been completed in tentative draft by a committee on bridge specifications of the American Society of Civil Engineers, and are to be presented for discussion at the coming annual meeting (Jan. 18-20). They have just been issued in printed form by the society. The new specifications follow closely along the lines of the 1920 A.R.E.A. specifications, with a number of minor changes, however, and without limitation to spans below 300 ft. Discussions will be received by the secretary of the society, 33 West 39th St., New York.

Handling Traffic During Highway Construction

Detouring Adds 25 Per Cent to Cost—Widening of Road Beds Suggested as Remedy

By Paul D. Sargent
Chief Engineer, State Highway Commission of Maine, Augusta, Me.

With double the number of vehicles and four or five times the number of construction projects, as compared with conditions five years ago, the traffic problem has grown out of all proportion to the increase in either factor. Road builders everywhere recognize these conditions and are making better provisions than ever before for the comfort and the convenience of traffic. Since the advent of federal aid, improved highway construction has been put on a much more substantial basis. Departments can now expend funds for handling traffic during construction without fear that they will be criticized for not getting every last mile of new road possible from the expenditure of funds in their hands. The work incident to handling traffic is fast coming entirely into the hands of state highway departments. When this is an accomplished fact and each department is fully equipped to handle this problem, much less criticism will be heard from the public.

Detour Division Favored

My own idea is that a special division to handle detours should be established, unless the organization of the department be such that the state is already divided into comparatively small administrative divisions so that the division engineer can keep closely in touch with the detour situation. In the department with which I am connected we have placed upon the resident engineer the duty of seeing that detours are put in good condition and kept so. At the same time we give each resident engineer more work than he can handle comfortably in looking after the new construction under his care. Naturally his first concern is to see that the new work is properly executed, and I am free to confess the detour road gets second attention. In some cases we have had our district supervisor, who looks after state-aid construction and all maintenance work, keep an eye to the detour. Under regulations now in force, if a detour is laid out over the ways in a town where we are building a state highway, the State Highway Commission sees that the detour is properly maintained during the construction season. This expense is shared equally by the town and the state. If we ordinarily have a patrol on the section under construction, we arrange to move the patrolman to the detour road. The expense of caring for that part of the detour located outside the town in which the improved road is being built is paid for wholly by the state and all detour expense is charged to the job under construction.

Signs are erected at each end of the detour and at all intersecting ways throughout the length of the detour, indicating the principal town or towns in either direction. Considerable difficulty is experienced, however, in keeping them intact. They are maliciously removed, taken down or destroyed.

The expense of caring for traffic over detour roads is larger than most people realize. For example, in 1920 the Maine department graveled 9 miles of road

to be used as a detour for the summer, with gravel only 4 in. deep and 12 ft. wide. The gravel was economically handled, being loaded and spread mechanically and hauled with trucks, yet the cost was nearly $1,000 per mile. The town widened and graded the road at its own expense.

The New Hampshire department reports one detour it is maintaining this year with a weekly payroll of $250 to $300 but the length of the detour is not specified.

The Division of Highways of the Department of Public Works of Massachusetts reports that the cost of maintaining detour roads has been from $300 to $1,200 per mile of detour. In one case the state expended $4,000 on a detour about 3 miles long.

Commissioner Bennett of Connecticut reports the case of a 7-mile detour over hard-surfaced roads, properly maintained and marked with signs, which were lighted at night, costing $3,000 for the entire job for one season.

Where detour roads cannot be located except at a very considerable increased length, some departments are now allowing traffic to go through the work. This necessitates building the surface one-half at a time and is objectionable from a construction point of view. In order to handle traffic in this way it is necessary to employ a watchman or flagman to pass traffic first one way and then the other. This is done in both Connecticut and Massachusetts.

Mr. Bennett, of Connecticut, cites this case: "We divided the construction work into two divisions longitudinally, and passed the traffic through by what is known as the one-way method—at first by the use of flagmen until it developed that on account of the numerous curves in the road, the expense of this method was prohibitory. We then hit upon the scheme of installing a field telephone set, with a small house at either end of the construction work, passing the traffic by a regular dispatch method, using no flagmen. The cost of this work varied from $60 per day, where flagmen were used for the 24 hours, down to about $12 a day by using the telephone."

The subject of passing traffic along or over work under construction is thoroughly treated in the last annual report of the Rhode Island State Board of Public Roads, which says in part:

"In general, a pavement which is cast, as is a concrete pavement, can more readily be built half at a time than can a pavement which must be rolled by a steam roller. Upon an 18-ft. bituminous-macadam road, unless there is a car track to confine the crushed stone laterally, almost inevitably there is a depression formed in the center of the road when it is built half at a time.

"The work of grading and laying foundations is also handicapped by this form of construction. If the excavation is to be accomplished so that traffic may always employ one-half of the road, hand work only can be employed, thereby increasing the cost. Frequently upon our projects at least 25 per cent more would be paid for building roads half at a time, and with some types of pavements inferior results would be inevitable."

I have discussed this question of increased cost incident to building pavements one-half at a time with a considerable number of contractors. Twenty-five per cent is the amount they have usually named as the probable additional expense. This is the amount assumed by the Rhode Island Board in their discussion. Even in the case of gravel-surfaced roads contractors have told me the added cost for constructing and finishing roads with traffic running over them is from $1,000 to $2,000 per mile, or from 8 to 16 per cent on the cost of the road.

Road Widening as a Solution

The ultimate solution of handling this traffic is, in my judgment, coming through the widening of present roads, which we shall surely see undertaken within the next ten years. If this work is done by first widening the grade before disturbing the present road surface, we shall have room to pass traffic on the original surface while the extra width of grade is being built. When subgrade and foundations have been completed on the new width of road, traffic can then be turned upon it while adjustments of grade and foundation work are being made on the original roadway. The surface or pavement can then be laid one-half at a time, for the width will be such as to make the laying of one-half at a time much more practical than is the case with a narrow pavement.

Traffic will be much better suited if allowed to pass along the highway under construction. Would it not be good business then to expend money, now used upon detour roads in paying the extra cost of constructing pavement or surface one-half at a time, in widening present roadbeds and temporarily surfacing them so that traffic can pass along the highway without unduly interfering with construction work? This would give us additional widths of shoulders, which is the greatest single element of safety, and would make room for future widening of the surface proper. The expense of such work, taking one mile with another throughout any considerable system of state highways, would not, I believe, average much more per mile than the expense of constructing and maintaining detour roads.

Corrosion of Buried Pipes To Be Tested

AN EXTENSIVE investigation of the corrosive action of soil on pipes used for gas and water mains and service pipes has been undertaken by the Bureau of Standards, in co-operation with the Bureau of Soils, the research sub-committee of the American Committee on Electrolysis, and the pipe manufacturers. Forty locations have been selected as representative of the principal families of soils to be found throughout the United States, and at each will be buried a number of samples of every kind of iron and steel pipe in commercial use, pipe coated with representative pipe coatings, and pieces of lead sheath cable, both plain and armored. Some of the samples will be uncovered and examined from time to time to determine the rate of corrosion. These fields tests will be supplemented by laboratory tests that will give complete data on the physical and chemical properties of the soil. Other laboratory tests will give the microstructure, complete metallurgical history, and chemical analysis of the pipe specimens. Extensive laboratory experiments will be conducted to determine the effects of variations in individual characteristics of both soils and pipe materials. It is expected that some data will be obtained within 2 or 3 years, but the experiment will probably continue over a period of 8 or 10 years.

"Serve Traffic" Is the Detour Slogan in Wisconsin

Policy Which Has Been Adopted Considers Detour, in Respect to Marking and Maintenance, as Main Route

By A. R. Hirst
State Highway Engineer of Wisconsin

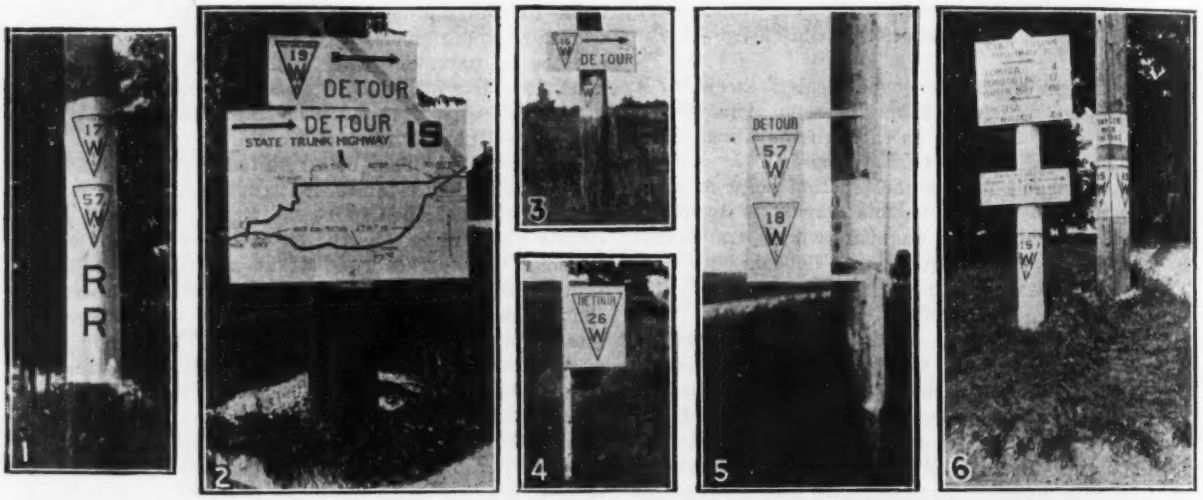
MODERN highway practice has reached the point where it includes not only the construction and maintenance of roads, but the giving of traffic service during the necessary construction and maintenance processes. Until recently, when a road was under construction or under extensive repair, or a bridge was out, it was standard practice to throw bars across the route and let traffic seek an outlet wherever it could find one. It did not seem to enter the minds of any of the state highway officials that this traffic should be cared for as thoroughly as normal traffic.

Wisconsin possibly recognized the newer phases of the traffic situation a little sooner than most of the other states. While we are far from reaching a stage of perfection, we have for some years past made an at least earnest effort to accommodate traffic during construction and maintenance processes.

Upon any piece of construction there are two options open to the engineer in charge. He may (1) close the road to traffic and provide satisfactory facilities for getting around the closed section; (2) keep the road open to traffic and get the traffic through the work as best he can. There are no other practicable means of doing the thing which must be done, that is, getting the traffic through day after day.

Whether a road should be closed to traffic, or whether traffic should be allowed to go through, depends so much upon the type of construction, the character of the soil and the roads available for detouring, that no fixed rules can be made. Undoubtedly where other roads are available which are travelable under all weather conditions, it is better to detour the traffic than to carry it through work where, in spite of everything which can be done, there is bound to be inconvenience, delay and possibly danger.

Decision to detour a road should be made as far in advance as possible so that the road to which traffic is to be diverted should be prepared for that traffic. This preparation should take place the year preceding the construction, if plans can be made that far ahead. Wherever the detour is necessarily narrow and dangerous and not much better than other roads in the neighborhood, the system of double detouring is very advisable. That is, traffic in one direction should be carried along one detour, and traffic in the contrary direction along an entirely different detour. Each case stands by itself and should be determined after careful consideration of all the factors.



WISCONSIN PRACTICE OF MARKING DETOURS AROUND ROAD CONSTRUCTION WORK

(1) Wisconsin route marking shown to indicate relationship between route marking and detour marking.
(2) Characteristic detour sketch placed at each end of long detours. Often these detour sketches at the beginning and ending of detours are miles away from the construction to be detoured.
(3) First type of Wisconsin detour sign.
(4) Second type of Wisconsin detour sign. Two roads are detoured on this same highway. Where right or left turns occur the "R" or "L" is used, just as on the regular routes.
(5) Latest and now standard detour marking, consisting of board bolted to angle irons driven in the ground. These are readily removable, can be placed near the roadside, and were so popular in 1921, due to their visibility at night, that the state will probably use this type of marking on all routes, both regular and detours, as soon as the change to this type of marking can be financed.
(6) Patrol section, direction sign, and route numbering on telephone pole.

It is often necessary and advisable to spend hundreds, and even thousands of dollars in preparing a detour from a main-line road, if the detour is to be in operation for a considerable period. Money so spent is not wasted, because detoured traffic is saved trouble and expense, and the improvements remain when the road reverts to its local use.

When the detours have been prepared and construction started on the main road, good stout barricades should be placed across the main road at the points of departure of the detour, with the necessary detour signs and arrows indicating the detour route. The detour route should be clearly and thoroughly marked from beginning to end, with the turns indicated and the dangerous points posted just as if it were the main traveled highway—as it actually is, for the time being. Detours should be as well marked in every way as the main roads, although the marking may lack some of the permanent features of the main-road markings.

The detour should be maintained daily because, since

it is usually an inferior type of road it will need this daily maintenance even more than did the main road. In brief, it is our practice in Wisconsin to put in effect on detours exactly the same practice for the same type of road as we employ on our state trunk highway system.

But even with the best principles and practice a detour is seldom as good as the regular route and is almost universally longer, sometimes dangerous and sometimes almost impassable. It is important, therefore, that the amount of traffic on detours be kept to the minimum, and about the only way this result can be accomplished is by the dissemination of information telling the public where detours may be expected. Given a proper distribution of this advance information much traffic will avoid the badly detoured roads, the situation will thus be relieved, and traffic served by being kept out of trouble. For some years the daily papers of Friday or Saturday have covered the detours existing for that week end in the neighborhood. This service has been an effective help in limiting travel on bad detours.

The Wisconsin Highway Commission this year tried further to meet this need of information as to detours by publishing weekly a blueprint map showing the location of all detours on the principal highways of the state, and also the location of all jobs under construction but which were not detoured. This map, a tracing on a scale of 1 in. equals 6 miles, was corrected each Wednesday in accordance with information received from the division headquarters that morning and the blueprints were mailed out to all subscribers to this detour service not later than Thursday night, so as to be available for the week end. The detour map service was furnished for sixteen weeks at a cost of $10; there were about 90 subscribers to the service in 1921.

Answers from a questionnaire to these subscribers indicate that the public was greatly served by these maps, and practically every subscriber indicated his intention to take the enlarged service along the general line which we expect to offer in the season of 1922. The map used is on a large enough scale so that the inquirer can tell approximately the location and length of the detour and where it starts, and can readily pick it up on the ground and follow it.

In 1922 when a road is kept open to travel, in addition to the care we have previously used in keeping the grading as smooth as possible, we will either build all culverts in halves or bridge the openings and new culverts with timbers so there will be no detouring through fields around culverts under construction, which has been the worst feature of our roads open during construction.

The accompanying photographs with their legends tell something more about the detour methods used in Wisconsin. We are not at all satisfied with our previous results. We are expecting to improve them materially in 1922 and succeeding years, but we believe that we have established some general principles which, if carried out to a logical conclusion, will enable us to give our people and our visitors really effective traffic service, despite the large mileage of road which we must necessarily have under construction each year.

The detour problem is of much greater importance than engineers have so far recognized. We are confidently expecting that one of the greatest advances made in American highway practice within the next few years will be made in the amount of care and attention and money spent in establishing and maintaining adequate detours.

Traffic must be served!

From the Producer's Viewpoint

Commercial and Technical Developments in the Asphalt Paving and Bituminous Road Fields

A Survey Based Upon Interviews With Representatives of the Principal Producers of Asphaltic and Tar Products Employed in City, County and State Highway Work

WITH 68,000,000 sq.yd. as the estimated area of roads and pavements of asphaltic types constructed or reconstructed during 1921, producers of asphaltic products regard the volume of this year's business as satisfactory and are looking forward to a substantial increase in the use of their materials on city streets and state and county highways during 1922. This prediction rests upon a more solid foundation than mere optimism. It is supported by a number of direct and indirect influences:

In the first place, the enactment of the Federal-Aid Highway Bill, which was signed by the President Nov. 9, and carries an appropriation of $75,000,000 to be matched by an equal amount from the states, assures a continuity of the road-building programs which all of the state highway departments have initiated. Bituminous types of construction will receive their share of the general road-building activities insured for 1922 by the new legislation. Second, the market for bonds, within the last few months, has shown a decided improvement and many issues which had been authorized but which could not be disposed of, except at a great sacrifice, are now finding a fairly ready sale. In general, it is felt that the improved credit situation will make its influence felt next year in the consumption of bituminous products for road construction. Third, the campaign, initiated by Secretary of Commerce Hoover, in favor of the fall letting of highway contracts as a means of relieving the unemployment situation, has been productive of results, especially in localities where winter work is possible, and an increase in the volume of next year's business is traceable, in part, to the acceptance of the principle, by many state highway departments, of advance planning. Fourth, reports received from city and state engineers indicate a marked expansion of activity for 1922. Such states as North Carolina, West Virginia, Missouri, Alabama, Florida, California, and others contemplate a substantial increase in the use of bituminous products in road construction next year. Fifth, the wider use of bituminous concrete foundations or "black base," instead of portland cement concrete, augurs well for an increased volume of sales of asphaltic materials for the coming year. Sixth, the endorsement of asphaltic filler for brick pavements by the National Paving Brick Manufacturers Association furnishes definite ground for the prediction of more

extended use of such products. Seventh, a considerable mileage of badly worn roads will undoubtedly be improved by the application of wearing courses of tar and asphaltic products by the penetration method and of asphaltic hot mix types such as asphaltic concrete and sheet asphalt. Producers report an increased demand for their materials in both penetration and mixed bituminous types of construction.

Larger Output Predicted

The foregoing is a composite summary of the views of representatives of leading manufacturers of asphaltic and tar products for road work as collected by *Engineering News-Record*. The following notes deal more specifically with certain phases of this year's operations in the bituminous road field, and are based on interviews with W. H. Kershaw, manager, Asphalt Sales Department, The Texas Co.; Herbert Spencer, Asphalt Department, Standard Oil Co. (New Jersey); J. R. Draney, general sales manager, Bitoslag Paving Co.; L. Wittenberg and J. S. Crandell, Tarvia Department, Barrett Co.; H. T. Macfarland, Barber Asphalt Paving Co.; and J. E. Pennybacker, secretary, The Asphalt Association.

The year 1920 was an unusually successful one from the point of view of the asphalt producer and showed a tremendous gain over 1919, following the termination of the World War. While the volume of the 1921 work is generally estimated to be in excess of that of 1920, the percentage increase is not so great as that between 1920 and 1919, for during the latter period a gain of about 40 per cent in total asphalt consumption was recorded by the U. S. Geological Survey. The 1921 output, however, is expected to show an increase of from 5 to 10 per cent over that of 1920. This is the Asphalt Association's estimate of the situation.

For one of the asphalt companies 1920 was a big year, the volume of business having been two and one-half times larger than during any other year; the 1921 sales, while they may not reach last year's mark, will compare favorably with it. A 20-per cent increase in business for 1922 is anticipated by this producer and by the Asphalt Association for the industry as a whole. Exceptionally large tonnages were shipped in October of this year, being several thousand tons in excess of the monthly shipments for any previous year. This increase is accounted for largely by the threatened railroad strike.

Credit Situation and Freight Rates

During the greater part of 1921 difficulty was experienced in disposing of highway bonds, particularly for improvements in the West. One of the asphalt refiners ascribes this as the cause for a slight falling off in its 1921 business. A number of bad accounts developed, due to the practice of paying road-building contractors in bonds and then having the value of these securities depreciate. Some contractors refuse to undertake construction work on the basis of bond issue payments. Nor are the refiners of asphaltic products eager to accept bonds in payment for their materials. Of late, however, the credit situation has shown a decided improvement, particularly in the Southeast, and unless unforeseen conditions arise this improvement should be reflected in increased road-building activity.

In the distribution of bituminous products the producers agree that no single locality during the year has developed a demand greatly in excess of that found in other sections of the country. In other words, the distribution throughout the states has been fairly uniform. One encouraging feature of this year's distribution has been the greatly improved railway service, offering a marked contrast to conditions in 1920. Freight rates, the producers believe, are unjustly high on asphaltic products. A comparison of the freight rates on asphalt with those on other road-building materials shows, in the opinion of one producer, a decided discrimination against the bituminous type of highway construction. One refiner, speaking of freight rates on asphaltic products now as compared with half a dozen years ago, cited a rate of $2.20 between Baltimore and Pittsburgh in the old days as against $5.20 a ton now.

The future trend of asphalt prices, as some of the producers see the situation, will depend to some degree on developments in the Mexican oil fields. By far the largest volume of asphaltic materials for road construction in the United States comes from Mexico and if the supply from that source should be curtailed, because of the inflow of salt water into the wells or by reason of political interference, asphalt prices in this country will stiffen unless other sources of raw material are developed in the meantime.

All of the producers were queried as to developments in materials, equipment, or construction methods during the past year. No far-reaching changes were indicated by their replies. In city paving work, due to the increased volume and weight of motor vehicle traffic, there is a tendency toward the use of a harder asphaltic cement in surface mixtures to prevent shoving and creeping of the surface. Another factor justifying the employment of a harder cement is the increased volume of oil drippings on pavements from motor vehicles, tending to soften the surface.

Bituminous Foundations

The producers believe that the next year or two will see a much wider use of bituminous concrete for foundations, instead of portland cement concrete. California is cited as a large user of "black base," while in repairs to the asphalt pavement on Fifth Ave., New York City, according to C. M. Pinckney, chief engineer, bureau of highways, Borough of Manhattan, the policy has been adopted, where cuts are necessary through the concrete foundation, of employing asphaltic concrete exclusively for the new foundation. Such practice is particularly advantageous in cases where the demands of heavy traffic require that a pavement, under repair, be put back in service at the earliest opportunity. It is noted, also, that the city of Providence, R. I., has employed black base for both sheet asphalt and granite block construction. It is understood, also, that North Carolina, in its plans for an extensive program of highway construction next year, is now considering the use of a sand-asphalt type of construction in localities where stone is scarce. In sheet asphalt paving work standard practice now requires, generally, the use of a 1½-in. binder and a 1½-in. top course. The close binder is almost universally used and the open binder abandoned.

In general, the refiners are in favor of uniform specifications. Some state and city officials, however, call in their specifications for asphalt of special consistency which cannot be met by the refiners' standard grades of material. The demand for these variations, it is pointed out, is a source of trouble to the asphalt pro-

ducer and involves increased cost at the refinery to provide storage for the special grades called for. The tendency toward the drafting of such specifications may sometimes be traced to the employment, by cities, of consulting chemists for whom variations of the standard specifications mean a larger volume of business. On the whole, however, the producers find no serious objection to the specifications which they are called upon to fulfill in supplying asphaltic materials.

Better Storage Needed

Contractors, to a much greater extent than in former years, are now calling for tank-car shipments of asphaltic materials instead of shipments in wooden barrels or metal drums. The manufacturers are endeavoring to secure a still wider use of bulk shipments and in many cases are co-operating with contractors in providing proper storage facilities within reach of the work. It is pointed out that tank-car shipments effect savings, for the contractor, of from $5 to $10 a ton exclusive of demurrage charged by the railways for tank cars remaining on sidings, involving additional costs of from $2 to $5 per day.

Many contractors have cut the cost of their work by installing storage tanks of their own. There are a wide variety of such containers on the market, including steel, concrete, and wood construction. Sometimes it is profitable, outside of city paving work, for contractors to construct temporary storage tanks and collapsible units for this purpose are obtainable. The refiners of asphaltic products find that there is opportunity for constructive work in educating contractors in proper methods of storing and handling asphaltic materials. In storage tanks, for example, it is important not to have too high a heat, which burns the asphalt. Ideal conditions demand a temperature just sufficient to allow the material to move freely. Steam in heating coils is expensive and with proper tank design it is believed that great economies in fuel consumption can be made.

In some cases contractors have repaired old railway tank cars which had outlived their usefulness as transportation units, by setting them up, calking them and repairing the steam coils. Such tanks may be rehabilitated and used as stationary installations.

Research

Research work in the asphalt and bituminous road fields includes two main lines of investigation—the shoving of asphalt surfaces and the effect of impact. The studies on shoving, now under way, are a co-operative effort by the U. S. Bureau of Public Roads, the Asphalt Association, and the cities of New York, Philadelphia, Baltimore, Washington and Detroit. Samples are being cut from city pavement in various localities, tested and analyzed with respect to consistency, amount of compression, grading of mineral aggregate, etc., in order to determine the best type of construction under given traffic conditions. Last year a service of impact tests on beams and slabs conducted by the Asphalt Association developed a number of significant facts regarding the design of pavements and demonstrated that asphaltic paving mixtures are highly resistant to impact. Impact tests on bituminous surfaces are now being conducted by the U. S. Bureau of Public Roads but the results have not as yet been announced. Another subject being studied is the relative wear of automobile tires on concrete and on bituminous surface roads.

According to the figures of the U. S. Geological Survey, asphalt production in the United States for 1920 was as follows:

ASPHALT PRODUCTION, 1920

	Short Tons
Domestic native	198,497
Imported native	128,414
Domestic petroleum	700,496
Mexican petroleum	1,045,779
Total	2,073,186

This output for 1920 compares with a total of 1,483,497 tons produced in 1919. The following are the 1919 figures, from the U. S. Geological Survey reports:

ASPHALT PRODUCTION, 1919

	Short Tons
Asphalt from domestic petroleum	614,692
Asphalt from Mexican petroleum	674,876
Domestic natural asphalt	53,589
Other domestic native products	34,692
Asphalt imported from Trinidad and Tobago	51,062
Asphalt imported from Venezuela	47,309
Other imported asphalts, including bituminous rock	7,277
Total	1,483,497
Asphalt exported from the United States	14,208
Approximate asphalt consumption in the United States	1,443,289

Alaska Railways, Roads and Harbors

PROGRESS on the U. S. Government railway in Alaska was delayed by lack of labor during the fiscal year ending June 30, 1921, according to the annual report of the Governor of Alaska. On that date there was a 72-mile gap between the north and south sections of the line. Since the report was made, however, the work has progressed so rapidly that the tracklaying gangs of the Alaskan Engineering Commission met on Nov. 19.

A 10-year program for highway development, including a system of feeders to the railway has been prepared by the Alaska Road Commission, which since 1905 has expended about $6,004,052 for about 5,000 miles of wagon roads, sled roads, trails, bridges, ferries and tramways. About 750 miles have a gravel surface and are suitable for light automobile traffic. A highway available for automobiles in summer is now completed from Valdez and Chitina to Fairbanks and is to be extended to Circle within the next two years. Of $666,789 spent in the above fiscal year, $432,244 was for construction and $234,545 for maintenance.

In the work of improving rivers and harbors a great advance was made, says the Governor, by the re-establishment of the Juneau district, in April, 1921, by the Chief of Engineers, U. S. Army. The president of the Alaska Road Commission was appointed district engineer, with the other two commissioners as his assistants. Nome harbor and the Apoon mouth of the Yukon river are the only works now authorized. The former includes two jetties at the entrance and the dredging of a basin. Ten new lights were established during the year by the U. S. Lighthouse Service. Better shipping facilities are said to be needed urgently, but the report states that the operation of government lines is not desirable.

The territory of Alaska shows no growth in population since the war, according to the governor's report. Mining is in a healthy condition and an agreement has been made between the Department of the Interior and the Navy Department for developing a coal supply for the Navy. This will require a coal washing plant. In oil prospecting there was great activity, and there is said to be an encouraging outlook for the early development of wood supply for the pulp and paper industry.

A Symposium and An Analysis

Large Mileage Highway Contracts

Reasons For and Against Developed by a Wide General Inquiry Among Highway Builders—Outstanding Arguments by Two Engineers and Two Contractors

LARGE mileage highway contracts are being advocated again, (1) to reduce the cost of construction and (2) to bring about quantity production. This renewed interest has developed from successful experience in southwestern states where, during the last year, single contracts have been completed for county highway systems of 50 to 150 miles.

Except in these few instances contracts for more than 20 miles of paved road are rare. Most contracts are less than 10 miles. The thought, in this practice, has been to limit the mileage of a contract to the length of road that can be constructed in one season with a single paving outfit.

Large mileage contracts would be the antithesis of present practice. The idea is to group improvement projects; award a single contract for the group, and carry on work with a number of outfits operated under common direction.

With the differences between large-mileage and small-mileage contracts stated in this simple manner the question appears plain. Will the large-mileage contract simplify engineering, increase production, improve quality and reduce cost? There are not enough facts to give the engineer a definite answer. There have been too few large-mileage contracts. Those that we have, have been undertaken under conditions of labor, railway service and materials supply which do not give the results normal significance. In a sentence, experience thus far with large-mileage contracts is merely indicative—not even tentatively conclusive.

With the facts inconclusive, what is the opinion? Here again the inquiry made leaves us uncertain. There is no agreement of opinion regarding large-mileage contracts. Contracting organizations large enough to handle such contracts advocate them; small contractors oppose them. A count of state highway engineers shows a small proportion strongly opposed, another small proportion moderately in favor and a large majority willing to grant a theoretical advantage but certain that conditions as they personally have them are not proper for success. A few manufacturers of equipment and producers of materials are vigorous advocates but in general the trades are indifferent. The value of large-mileage contracts is consequently affirmed on one hand and denied on the other.

Affirmative Opinion

It is contended that more efficient engineering, both in the field and in the office, is practicable with large mileage contracts. The mileage under construction is concentrated and fewer engineers per mile will serve the work than when several scattered small contracts make up the same mileage. Also fewer engineers are required because with the skilled superintendence provided by large contracting organizations less personal supervision by the engineers is required. By being longer engaged on one operation the men work faster and with less lost motion than where frequent shifts from one operation to another are necessary. As direct evidence, R. J. Windrow, state highway engineer, reports from Texas, where large-mileage contracts have been most employed, that there is a "reduction in the engineering cost per mile of construction."

Speed of construction will be increased because large contractors are financially able (1) to accumulate large stocks of materials (2) to provide the largest and best equipment and (3) to secure the most capable superintendence. They possess an organization trained in quantity production and, by practice, geared up to high speed operation. The direct evidence is several contracts in Texas where single high powered organizations are paving a mile a week. Particular reference is made to the Maricopa County contract in Arizona (*Engineering News-Record*, May 26, 1921, p. 882) for 150 miles of concrete road where the contractor is producing his own materials and is distributing them to three proportioning plants which serve three paving outfits averaging each a mile a week of completed pavement.

Better construction follows from the greater skill and proficiency of organizations able to handle large contracts. They have the means to employ the best methods and machinery; they have greater market resources and, therefore, a wider choice of materials, and they command the most experienced superintendents.

Cheaper construction is possible because (1) the investment in equipment is less per mile of construction, (2) the plant operating costs are less per mile of work and (3) overhead expenses are reduced. An unloading plant (crane, charging bins, storage facilities, track) capable of handling 20 cars costs considerably less than two 10-car plants. Also it does not require many more men for its operation than does each of the smaller plants. Overhead is less because of smaller bidding expenses, smaller labor turnover, less superintendence and accounting.

There is finally a broad constructive purpose in fostering the large mileage contract. It will develop large organizations specializing, and becoming highly expert, in highway construction much as the great railway organizations of past years were developed. No large road building program, it is contended, is possible without such large organizations and they cannot operate without contracts which engage their full resources in money, plant and personnel.

Negative Opinion

Reliable contractors able to finance only eight to ten miles, or a one-unit outfit, would be eliminated by large mileage contracts as direct bidders and forced to become subcontractors. This deprives the small contractor of the opportunity to do original work and puts the community to the disadvantage of dealing indirectly with its contractors actually doing the construction. These small contractors personally in touch with the actual construction are doing as good work and often cheaper work than large organizations. Finally contractors able to undertake large mileage contracts are too few in many states to complete the mileage desired.

A large mileage of continuous or connecting road is torn up in one season and excessive local interruption of traffic is caused if contracts are let in large mileages.

Large mileages under construction on the same line of railway complicate materials deliveries. Railways have a limit of service which they can render a section of territory in any one classification of freight and when this limit is exceeded the service is not efficient.

Contracts for large mileages, if forfeited, cannot so easily be recovered and relet or completed by force account. Effective pressure cannot so easily be exerted on a dilatory contractor.

Too much mileage under construction is carried over into the succeeding year and clean cut yearly programs so desirable in securing legislative action on appropriations are difficult to arrange.

Law and custom in initiating and developing highway improvements, curtail in almost every state the freedom of the highway engineer in locating new construction and planning the contracts. The more common of these limiting conditions are:

(1) In some states improvements are initiated and carried out only by "districts" created by the residents without regard to county or township boundaries and responsible to no one but themselves.

(2) In many states road improvement is initiated and carried out by the counties under laws which require approval of plans by the state highway department but which deny any initiative to the state.

(3) In many states previous county control of highway improvements has left for state construction only short gaps between county systems.

(4) In all states "distribution" of annual improvements is "politically" desirable in securing appropriations and favorable legislation.

(5) The "habit" of the people is to build from year to year, cleaning up each year's work and planning independently for the next year.

The obvious conclusion from the information presented is that the large-mileage contract cannot be analysed purely as a problem in engineering planning and construction. The appraisal of its possibilities as general practice on this basis alone is, therefore, largely academic. About all that can be affirmed is that:

1. In actual practice large mileage contracts have given satisfactory results in speed, quality of work and reasonable cost when handled by contractors of means and ability.

2. Until they have been far more widely used under more nearly normal conditions no exact measure of their value can be made compared to small-mileage contracts.

3. Their employment is, in any event, an engineering and business question to be decided in each case by the conditions governing the operation.

There follow four short articles giving the opinions of two contractors and two engineers on this subject.

* * * * * *

Finish Each Season's Work That Season

By Clifford Older
State Highway Engineer, Illinois

THERE is no advantage in letting in a single contract a section of road which may be longer than that which a contractor can economically construct from one set-up of his plant.

Just how many miles of road may be built with a single plant installation depends upon the character of the equipment used; but ordinarily, it varies from eight to a maximum of perhaps sixteen miles, although in the experience of Illinois there is but one instance where a contractor constructed sixteen miles of road with one set-up. Also under Illinois conditions, a single set-up usually means a season's work for an outfit.

The advantage to a contractor of having two sets of equipment close to each other is comparatively small and may easily be offset by the advantage to the public in advertising for contracts in such manner that competition may be secured from a greater number of contractors than would be possible were 40 or 50 miles tied up to one bidder.

Under the conditions prevailing during the past several years there is nothing to be gained in awarding contracts we may not reasonably expect to be completed in one season.

It is therefore my judgment that in advertising for proposals on road work it is the best policy, from the point of view of the public, to provide as nearly as may be for contract sections having such location and magnitude as to permit of a season's work for a well balanced outfit.

Further provision may well be made that proposals may be submitted for adjacent contract sections in combination so that an organization with several outfits may compete for the whole work and, if it is the successful bidder, will have its various construction outfits in a comparatively restricted territory.

Consideration should be given to the fact that where very long continuous projects are located along a single railroad, rail transportation difficulties may be involved which might otherwise be avoided.

Large Contracts Cut Plant Costs

By H. H. Wilson
Managing Partner, Winston & Co., Contractors

LARGE and highly developed contracting organizations can operate successfully only on extensive contracts. Quantity production means reduced cost; furthermore, where a contractor is awarded sufficient work in one locality to give him employment for as much as two years time, great economies can be effected in the cost of freight on plant, depreciation on plant, camps, and other structures.

Generally, it is also possible to assemble on long term contracts a more experienced, efficient and economical organization (both as refers to skilled and unskilled labor) than is possible to assemble for a few months' work.

Under existing freight rates, the item of freight on plant alone (where the portable railway and other extensive and modern road building equipment is used) will average more than $500 per mile of road.

To "plant" a six-mile road contract requires a heavy investment in equipment. In buying this the average contractor has no assurance as to the amount of depreciation he will be able to earn. If, however, he is awarded sufficient work and allowed sufficient time, within which to complete it, to admit of earning two years' depreciation on his equipment, he will be willing to compute his plant depreciation on a lower annual percentage than he would be willing to do with the assurance of only one year's work.

Offsetting the above considerations a small outfit on a small contract has little or no overhead expense, and, given ample time, can produce economical results.

However, when the efficiency and reliability of a large and intelligently conducted organization is contrasted with that of an organization of the "wheel-barrow" and "sidewalk paving" type, there are further equities in favor of the large organization, both for the State and for the taxpayers.

Small Contractors Underbid Large

By F. F. Rogers
State Highway Commissioner, Michigan

THE Legislature of 1913 established a trunk-line road system for Michigan which has practically been doubled by subsequent Legislatures up to and including the Legislature of 1921. Until 1919 the several counties had charge of the building of the trunk line roads and were encouraged by the state paying double the amount of aid on trunk lines that it

paid on non-trunk lines. In addition the state took charge of and built all bridges of more than 30 ft. clear span on the trunk lines providing the local subdivisions would build at least three miles of road including the bridge.

Very naturally, under such a law, the roads in the various counties were built out from their most important towns and there were many gaps left which it became necessary to fill in in order to get anything like a continuous system of trunk lines over the state.

Therefore in 1921 when the Legislature placed the construction and maintenance of trunk lines entirely with the State Highway Department, but still with some local financial co-operation, the work of the state was evidently a gap filling program. For this reason, it has been impossible, say nothing about being impracticable, to place large transstate trunk lines under contract at one time. The longest single pieces of road that we have been able to let are from ten to fifteen miles.

There is still considerable argument as to whether large companies may be able to step in and compete with the smaller contractors, working on smaller pieces of public highways. In fact we have usually found it necessary to divide our roads into sections for letting in order to allow the smaller contractors to bid; otherwise a few large contractors would bid off the roads at prices unduly high. At least that has been the experience of Michigan.

It is a literal fact that the smaller contractors have underbid the larger ones and I know that a careful study of the unit prices on all contracts awarded in Michigan during the past two years would not show that there is any advantage in letting very large contracts, if the only object is to get reduced prices.

Railway Experience Supports Large Contracts

By J. C. Baxter
General Superintendent, A. Guthrie & Co., Inc., Contractors, St. Paul, Minn.

THE greatest amount of construction ever performed of a character in any way similar to modern highway work, was the construction of the American railway system. This work, carried on through three-quarters of a century, was largely performed under a plan that gradually became standardized and was almost universal until the combination of the Great War, the Adamson Act and the War Labor Board put a damper on the extension and betterment of railways. This plan was applied to work performed for private owners whose first consideration was economy, and it may safely be assumed to have been the most efficient that could be devised by the group of brilliant minds who planned, financed and constructed the American railway system as it exists today.

The plan in question as applied to the construction of new lines of railway, undertakings in their general physical characteristics very similar to modern highways, was, for the railway company to request bids on the entire amount of work contemplated, requesting such bids only from firms of known experience and financial resources. After one of these firms had been selected and a contract entered into, the successful bidder immediately proceeded to sub-let various portions of the work to other firms who were each especially equipped to handle the piece of work in question, and these sub-contractors executed certain portions of the work with their own forces and equipment and sub-let certain other portions to so-called, "station men" who were in reality "piece workers."

This plan resulted in an almost perfect organization. The general contractor was financially responsible for the entire work and directed and supervised it, strengthening financially and with equipment, any weak spots that developed. The sub-contractors were financially responsible for small portions of the work and gave this work their personal supervision, and finally a large portion of the work was performed on a piece work basis, than which a better plan for paying workmen has never been devised.

That this plan of contracting work was successful from an economic standpoint, is shown conclusively by the results obtained in the years from 1880 to 1910:

In 1880, common labor was receiving approximately $1.50 per day and earth work was let by railway companies to general contractors at about 18c. per cubic yard.

In 1910, common labor had advanced to $2.25 per day and earth work was still being contracted for at about 18c.

In other words, while wages increased 50 per cent in thirty years, the skill of the contracting firms bidding on large units of work during that period was sufficient to improve methods so that the cost to the owners did not increase.

So much for the historical aspect of the case; now as to the direct economies:

First, Economy in Manpower: The writer's firm recently constructed thirty miles of rather heavy highway under one contract and on this work, one superintendent supervised the entire job; one paymaster paid the entire job; one bookkeeper kept accounts for the entire job; one purchasing agent made all purchases for this job as well as several others; two general supply trucks served the entire line for miscellaneous supplies; one set of office and store buildings served the entire line; one employment manager secured labor for the entire line, and finally, and most important of all, the work apportioned to each sub-contractor, was of such character and magnitude that his equipment and organization were kept employed throughout the entire season, and no unnecessary moving of men and machinery was entailed.

It will not be necessary to go into detail as to the increase in overhead that would have occurred had the work been awarded to say, five separate firms with five local organizations covering the ground. As a matter of fact, our bid for the work in question, was substantially lower than the lowest combination of bids on the four separate sections into which the work was divided, and we completed the work on time with a small but satisfactory profit.

Second, Economy in Use: The writer is familiar with the following condition and there are many more like it scattered over the entire country: Twenty miles of highway grading was let in four separate contracts, all for completion this fall. One of these contracts was for the reconstruction of the old highway in a location where six miles of additional distance was required in the detour. As was to be expected, this piece of work, (an unattractive job) fell to a new and unseasoned small firm which has failed to complete the work and has also failed financially, the result being, that it will be well into the middle of next summer before this portion is completed, and some fifty automobiles a day will be required to travel some six miles a day for six months, which at 10c. per car mile amounts to about $5,400.

Third, Economy in Use of Public Money: This is an economy that follows automatically from economy in manpower and economy in use. The writer's opinion is, when highway work is consolidated into projects containing from fifty to one hundred miles of work, that from 3 per cent to 10 per cent would immediately be saved in the first cost of the work, besides gaining the additional advantage of having large, well seasoned firms responsible for the completion of the work on time.

Proposed Pueblo Flood Remedies

In speaking recently before the Denver Civic and Commercial Association on "Flood Prevention in Pueblo," Arthur E. Morgan stated that the flood last June was probably more than half of the maximum flood that could occur according to investigations so far carried out. On the several methods which present themselves as a solution he commented as follows: Construction of a dam just above Pueblo is feasible but very expensive. Diversion of the channel of the river to the west bluffs would probably involve too much of a change in city properties. Increase of the present channel to more than twice its size would also probably be too expensive and involve too many property changes. Construction of a levee on the east bank of the river would be the least expensive.

Relation Between Molded and Core Concrete Specimens

Pennsylvania Test Show Concrete Drilled From Highways Higher in Compressive Strength —Specimens Often From Same Batch

By H. S. Mattimore
Engineer of Tests, Pennsylvania State Highway Department

For many years compression strength of concrete has been determined, to a large extent, by the strength obtained on specimens molded of a mix proportioned the same as that used in the structures under consideration. These specimens, at first, were made entirely in the laboratory under ideal laboratory conditions. Further development along this line was the molding of specimens at the construction site.

A study of the comparative results of these tests on laboratory- and field-molded specimens revealed, in numerous cases, a considerable difference in strengths in mixtures of the same proportions. Studies to determine the reasons for these differences have resulted in considerable progress towards rational design of concrete mixes. This is due mainly in determining many factors which have their effect on field-mixed concrete.

The ideal condition in all concrete tests is to develop methods by which we can pre-determine the strength in the structure by preliminary tests and thereby truly design the mix to meet conditions. At the present time I do not believe the art has progressed to this stage, especially as tests along this line have indicated that the general tendency of concrete drilled from the structure is to show a higher test in compression than the preliminary molded specimen would indicate.

TABLE I—COMPARISON OF MOLDED AND DRILLED CONCRETE SPECIMENS—1:2·3 MIX

Compression Strength Lb. per Sq. In.

Series No.	Molded Specimens Age Days	Max.	Min.	Mean	Drilled Specimens Age Days	Max.	Min.	Mean	No. of Spec.
1	28	4,740	2,690	3,545	330	6,061	4,210	4,728	5
2	28	4,054	2,211	3,095	300	6,070	3,980	4,543	13
3	28	3,315	2,115	2,788	300	5,452	3,860	4,706	5
4	28	4,357	2,229	3,368	300	6,585	4,185	5,288	8
5	28	3,896	2,646	3,397	320	5,001	3,047	3,907	7
6	30	3,928	3,215	3,505	300	5,672	3,868	4,966	9
7	7	1,992	1,405	1,721	60	4,599	3,402	4,044	4
8	7	2,486	2,123	2,285	90	5,454	4,769	4,993	4
9	7	2,914	1,374	2,016	150	6,598	3,930	5,304	11
10	28	3,525	1,884	2,524	400	5,468	3,539	4,669	8
11	28	3,566	2,234	3,055	460	5,468	3,676	4,954	4
12	7	2,420	1,947	2,042	80	6,286	3,517	4,561	8
13	7	2,960	1,876	2,241	140	5,613	3,664	4,399	9
14	7	3,118	1,847	2,233	150	4,423	3,345	3,634	5

Table I is a summary of data on molded and drilled concrete specimens, obtained during construction and from the finished pavement of the Pennsylvania highways. The molded specimens were cast in the field and cured under the same conditions as the pavement. These were tested either at 7- or 28-day periods. The drilled specimens are cores taken from the finished pavement by a field core drill. It was found difficult to secure these latter at given ages due to the geographic situation of the highways. Molded specimens were cast from concrete being laid in the pavement and accurate data were recorded of the exact spot where the batch was placed. The drilled specimens were taken at the same place and from the same batch as near as practicable.

It will be observed that the general tendency is toward considerably higher strengths in the drilled specimens. This is affected to some extent by the difference in age but the variation in age in the drilled specimens of the different series also indicates that other factors exert a greater influence than the age. Further, the strength of the molded specimen is not a positively reliable indicator of the strength of the concrete in place, as determined by the drilled specimen. This fact further demonstrates itself in Table II, which illustrates the detail test of one of the series from which the summary is compiled. It is also especially notable in this table that the drilled cores of the highest strengths are not always opposite the molded specimens of the highest values.

TABLE II—DETAIL DATA OF SERIES NO. 2 (Table I)

Molded Specimens Age	Molded Specimens Strength	Drilled Specimens Age	Drilled Specimens Strength	1:3 Sand Mortar Tension 7 days Lb. per sq. in.	1:3 Sand Mortar Tension 7 days % Ottawa	Cement Tensile Strength 7 day	Cement Tensile Strength 28 day
28	3,526	360	4,757	367	133	280	393
29	4,054	330	5,353	313	105	280	393
28	3,331	330	5,141	318	103	280	393
28	3,061	240	5,070	312	121	280	393
28	3,304	240	6,070	442	161	280	393
28	2,783	240	3,980	315	124	380	393
28	2,211	210	4,650	428	178	280	393
28	2,821	240	3,931		102	280	393
28	2,489	270	4,640	383	147	280	393
28	3,152	270	4,025	317	125	280	393
28	3,146	300	4,405	312	113	280	393
28	2,528	300	5,024	314	118	280	393
28	3,834	330	4,008	311	107	280	393

The taking of the molded and drilled specimens from the same batch reduces, to a large extent, the effect of a difference in consistency; in fact, special efforts were made to control the consistency in all concrete construction and determinations on this at various periods during the laying of concrete have demonstrated that it is controlled within narrow limits. This does not only refer to the one project but throughout all of the construction work.

Research work on the comparative strength values of laboratory- and field-molded concrete specimens has led investigators to seek the factors which affect the compression strength and this has resulted in valuable contributions toward this solution. Further research on the comparative strength of molded and drilled specimens should guide us toward determining the variables which affect these strengths, the ultimate result being progress towards rational design of concrete mixes. In other words, we could design mixes of known strength in a structure by preliminary tests on molded specimens. We must arrive at this stage to design mixes, either by eliminating the variables or ascertaining their value and allowing for them.

Present Value of Compression Tests.—Although preliminary tests on molded field specimens are not a positively reliable indicator of the strength of the concrete in the finished structure, they have a great value on individual projects and such control should be encouraged. Molded specimens taken at regular periods on any concrete construction will indicate any great difference in strength and lead to an investigation of causes. So far as I know, this is the only method of detecting these defects and an experience of six or seven years of this method of control has proved an economic procedure.

At the same time, I believe extensive tests should be carried on to determine the comparative relations between molded and drilled specimens. The drilled specimens furnish us with an assurance of the actual strength obtained. The test on these latter has been of inestimable value in our work. Reference to Tables I and II gives us convincing proof that our pavements have an excellent factor of safety so far as compression strength enters into the design.

Multiple-Batch Charging Plant for Truck Haulage

Shuttling Measuring Hoppers Under Twin Bins Charge Four Batches of Sand or Stone in One Operation

ON CONCRETE road construction late last fall, remarkably fast charging of four-compartment motor trucks with proportioned batches was accomplished by using a central proportioning plant consisting of twin bins of steel, with eight measuring hoppers so mounted on a rolling frame underneath the bins that sand or stone could be charged into four hoppers at once and four hoppers at once could be discharged into the truck compartments. Specifically, on the maximum day's run of 511 ft. of 18 ft., 6-8-6-in. slab, the outfit loaded 62 trucks with 248 six-bag batches in 9¾ hr. actual operating time. This output of material was below the practicable capacity of the charging plant as is reported by the contractor elsewhere in this article.

The plant was used by the Chas. H. Fry Construction Co., of Erie, Pa., on the Crowley Road just east of

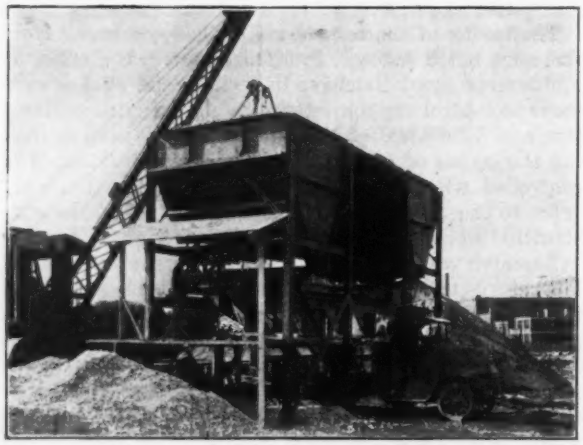


FIG. 1. CENTRAL AGGREGATE PROPORTIONING PLANT WITH TRUCK BEING LOADED

Erie. This road was 5,375 ft. long, of one-course reinforced concrete. Bids were not opened until Sept. 27 and it was several weeks before the contract was signed. However, the contractor was able to get enough grading done to start pouring concrete on Oct. 16. Due to the lateness of the season, bad weather interfered with the progress of the work, reducing the morale of the crew, and preventing its working at the efficiency which could be obtained on a longer job, or in mid-season.

The work was done under Pennsylvania State Highway Department standard specifications, and under the supervision of F. E. Winter, district engineer. Among the principal requirements of the specification were the following: A 1:2:3 mix, using coarse sand and crushed stone; the aggregate cannot be dumped on the subgrade; the aggregate must be accurately measured and each box struck off level full; the batch-meter must be set so that the concrete is in the mixing drum 1½ min. from the time the loading skip starts down until the dumping chute is opened.

At one time the mixer crew caught up to the graders, but with this exception the progress of the work was entirely up to the mixer, where it properly belongs. City water supply was used at first, but the pressure was inadequate and caused delays until a pump was installed. At one place the pavement was laid through a subway under the main line of the New York Central and Nickel Plate railroads, and as the head room was not sufficient for the mixer, this part of the work was slow. Due to the weather conditions, the mixer crew worked only 107¾ hours in 14 days, and under these conditions averaged 44 lin.ft. per hour. The paving organization consisted of four crews composed as follows:

Proportioning and Loading Plant: 1 crane engineer, 1 fireman, 1 man operating aggremeter and 2 men on cars.

Mixer Crew: 1 engineer, 3 men placing concrete, 1 man finishing, 2 men dumping cement, 1 water boy, 1 fireman, 2 men on tamping board, 5 laborers, 2 men setting forms and 1 pump man.

Handling Cement and Reinforcing: 1 driver with team drawing two wagons and 3 men unloading cement cars to wagons.

Hauling Aggregate: 3 truck drivers.

With these gangs of 31 men and 2 foremen, and the equipment listed in Table I, the average output was 440 ft. in 10 hours or 2.67 sq.yd. per man hour. The grading crew of nine laborers, one team and driver, and one roller engineer is not included in the above figures, as the grading was considered a separate item of the contract.

TABLE I—MAJOR EQUIPMENT LIST, CROWLEY ROAD, ERIE, PA.

1—Type "B" Erie Crane, boom 32 ft., with ¾ cu.yd. Blaw clam shell bucket.
1—Erie Aggremeter having two 35-ton bins and aggremeters arranged for four-compartment trucks, six-bag batch, 1:2:3 mix.
1—21-E Foote Steam Paver with gravity chute.
3—5-ton Mack Trucks with four compartment steel bodies.
1—10-ton Buffalo-Springfield Steam Roller, with pressure cylinder scarifiers.
1—Fresno Team Scraper on fine subgrade.
1—Electric driven Pump for furnishing water for mixer, etc.

As indicated, the central proportioning plant, Fig. 1, consisted of a revolving crane and a ¾-cu.yd. clam shell bucket; all-steel hopper bins and measuring boxes, and a cement unloading plant. The crane unloaded coarse and fine aggregate into the hopper bins or onto stock piles. Rail deliveries and stock pile space were ample and no delays resulted from lack of stock at the proportioning plant, or of material at the mixer. The outfit for measuring aggregate and loading trucks was

TABLE II—LOADING PLANT RECORD ON CROWLEY ROAD, 5,375 FT. ONE-COURSE, REINFORCED CONCRETE

Date Started, Oct., 1921	Lin. Ft. Concrete Placed	Batches Loaded	Truck Loads	Mixer Pouring Time, Hr.	Delay, Hr.	Cause of Delay
16	314	162	54	8	..	Late start
17	400	209	70	10	..	Planked subgrade
18	421	207	69	10	1	Snatch team on each truck for 300 ft., going
19	371	183	61	8½	1	under bridge and bursted water line
20	..	..	..	Rain	..	.....
21	432	221	67	9	1	Going under bridge and engine trouble
22	368	168	42	8	2	Many delays repairing and replacing cable on mixer
23	256	124	36	6½	3½	Broken mixer
24	124	61	21	3½	..	End of section and moving mixer
25	345	168	43	7½	..	Late start
26	417	204	51	9½	½	Water trouble
27	202	96	24	4	..	Held up on account of grade
28	511	248	62	9	¼	Mixer trouble
29	375	181	47	9	1	Held up on account of grade
30	200	99	33	4½	5½	Grading delay 2 hr. Broken mixer ½ hr.

called on to load only 2,331 six-bag batches, Table II, or 680 truck loads of three or four batches each, whereas the contractor states that it was capable of loading 2,700 trucks, or 10,800 batches in the same number of days, working 10 hours per day, enough to have laid 4 miles of the same road which would put the progress of the job up to the capacity of mixer.

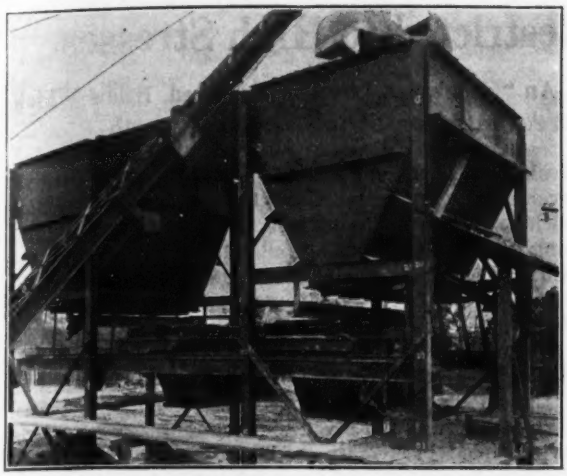


FIG. 2. BINS AND CARRIAGE WITH MEASURING BOXES

Three five-ton trucks, Fig. 3, were used to haul the aggregate to the mixer and only one laborer was required to operate the plant, exclusive of the crane and car crew. This laborer loaded the measuring boxes and moved them out over the truck for loading. The time consumed after the truck was backed under the measuring boxes, loading both fine and coarse aggregate, and until the truck pulled out, was from 60 to 75 sec. per truck. Four batches were dumped into the truck body simultaneously by the truck driver.

In detail the proportioning plant, Fig. 2 consists of two principal units: the bins of which there is one for sand and one for stone, and the "aggremeter," or measuring device, of which there is one under each bin. The bins are of all-steel construction and are so designed that they can be taken apart and shipped from one location to another. Their capacity is about forty tons each of stone and sand. This capacity allows a temporary shut-down of the equipment used in filling the bins, but it assumes that a storage pile will be used in addition.

FIG. 3. FOUR BATCH BODY WITH HINGED PARTITIONS

At the bottom of the bins are gates for discharging the material, the number of gates depending on the number of batches which are to be hauled at once. For example, if the motor truck is divided into four compartments, there will be four gates at the bottom of the bin. The bins are located side by side with a space between them into which the truck runs for loading. An operator's runway extends underneath one bin, across this space, above the truck and under the other bin.

The measuring device consists of a carriage on which are mounted the measuring boxes of the proper cubical capacity which it is desired to measure; in the above case four boxes were mounted on each carriage. The carriages are tied together so that when one carriage is being filled from the loading bin, the other carriage is in dumping position over the truck; while sand is being loaded into the measuring boxes of one carriage, for example, stone is being loaded into the truck from the other. The carriages are propelled in either direction on the runway by a single-drum, geared, reversible hand winch.

Carried under each bin at one side is a strike-off plate so located that as the measuring boxes roll along the track from underneath the bin to the loading position of the truck, they must pass underneath the strike-off plate. By this means the boxes are all struck off level full. The motor truck drives under the track extension, or runway, the carriage with each box containing the exact amount of material required for one batch is rolled out on the runway over the truck, and the material is discharged from the bottom of the boxes to the compartments of the truck.

The doors of the boxes in each carriage are all opened and closed by means of one handle operated through a spur gear reduction so that the operator can easily control the speed of opening the doors and drop the material gradually into the truck. This eliminates hammering action on the truck springs. The weight of material dropped at one time is 7,000 lb. when hauling four batches for a six-bag mixer, with a 1:2:3 mix, and if this material were dropped suddenly, the life of the truck would be greatly reduced. The effect of this blow is further lessened by the fact that the cab of the truck does not have to clear the bottom of the boxes since the boxes are rolled out into place after the truck is in position. Otherwise the material would drop three or four feet further than it does.

A plant having four-batch boxes can be quickly changed to load trucks having two or three compartments by a simple latching device, which enables the contractor to use trucks of different capacity without delay. The size and proportions of the batch can be changed quickly by bolting fillers to the vertical plates of the measuring boxes.

This new proportioning plant was built by the Erie Steel Construction Co., Erie, Pa.

Philadelphia Urged to Hasten Sewage-Works

In urging that the city of Philadelphia expedite its program of intercepting sewer and sewage-works construction, for which the Commissioner of Health granted a permit Aug. 30, 1915, Dr. Edward Martin, the present commissioner, made the following statements in a letter sent to the City Council late in December, 1921: "Since 1912 the city of Philadelphia has made examinations of the water of the Delaware River to determine the amount of dissolved oxygen which it contains, and each year shows decreasing amounts. Observations made last September show that the water of the Delaware is now polluted to a serious extent, as evidenced by the almost complete exhaustion of oxygen in certain samples. The excessive sewage pollution of the river is also shown by the practical cessation of the shad fisheries at Gloucester, as the water is so polluted by sewage that the shad no longer come up the Delaware River for spawning purposes."

Alternating-Stress Fatigue Restricted to High Stresses

First Report of Joint Committee on Fatigue of Metals—An "Endurance Limit" Discovered, Below Which Stress Repetition Is Borne Indefinitely—Limit Appears Related to Ultimate Strength

DEFINITE results of great significance have been brought to light by the co-operative joint investigation of the fatigue of metals which has been under way during the past two years in direct charge of Prof. H. F. Moore at the Illinois Engineering Experiment Station, Urbana. After the early discovery that the test technique produced highly uniform and comparable results, it soon developed that no fatigue failures occurred so long as the extreme fiber stress applied in the reversal was kept below a certain fixed limit. This limit ranged from about 25,000 lb. for the softest steels to nearly 100,000 lb. for the strongest. Further, on comparing the values of the endurance limits for the different steels tested with the values of the other physical properties of these steels, no relationship could be found with any except ultimate strength and Brinell hardness. In other words, the ultimate strength and the hardness of a steel appear to be (roughly) representative of the endurance strength of the metal, or the stress which may be applied *without development of fatigue*. Roughly, the endurance limit appears to be about *one-half the ultimate strength*, and 250 *times the Brinell hardness number*. A report of the work to date is just being issued by the Engineering Experiment Station as Bulletin 124, by H. F. Moore and J. B. Kommers.

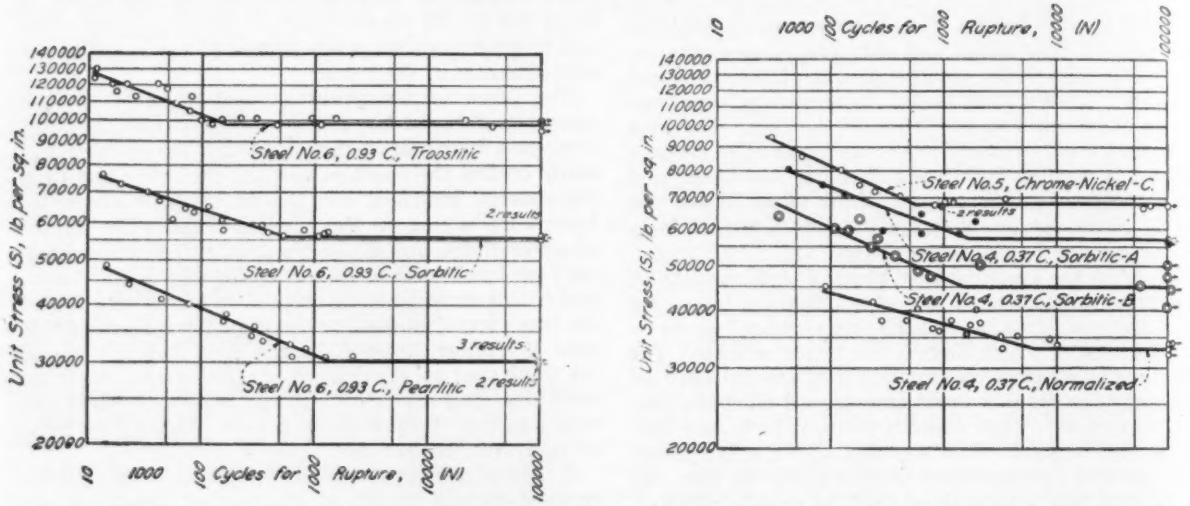

Unit Stress, (S), lb. per sq. in.
Cycles for Rupture, (N)
Steel No.6, 0.93 C., Troostitic
2 results
Steel No.6, 0.93 C., Sorbitic
3 results
Steel No.6, 0.93 C., Pearlitic 2 results
Steel No.5, Chrome-Nickel-C.
2 results
Steel No.4, 0.37 C., Sorbitic-A
Steel No.4, 0.37 C., Sorbitic-B
Steel No.4, 0.37 C., Normalized

FIG. 1. RELATION OF UNIT STRESS TO NUMBER OF STRESS REPETITIONS FOR SEVEN TEST SERIES, EXHIBITING THE ENDURANCE LIMIT PHENOMENON

General Scheme of Work Done

Steels only were tested in the work so far reported. These ranged from very-low-carbon ingot iron to steel of 1.20 C, and to 3½ per cent nickel and chrome-nickel steels. Most of the metals were subjected to several different heat treatments. Thus a large range of steel grades was tried, with ultimate strengths ranging from 42,000 to 188,000 lb. per sq.in., yield point from 19,000 to 130,000, and elongation from 8 to 48 per cent. Cylindrical test specimens of each material, of 0.30-in. minimum diameter (ends slightly enlarged to insure breakage near center) and 13-in. lengths were tested in reversed bending by rotation when supported in a small machine arranged like a lathe and loaded by a weight hung from two ball-bearing collars clamped on the specimen; the specimen was rotated by electric motor. The test apparatus is a development of those devised by Wöhler, Sondericker and Farmer.

For any one test, the loads on the rotating beam were adjusted to produce a predetermined extreme-fiber stress at the middle of the specimen, and the machine was started rotating; the revolution count was taken when the specimen broke. It should be remarked that all specimens were polished by a definite process, identical for all, in order to minimize the influence of surface imperfections or roughnesses on fatigue fracture.

When the number of reversals required for fracture at one stress had been determined, a slightly lower stress was tried, and so on until a series of values was obtained. When numerous readings of this kind were plotted (to logarithmic scale), sloping lines as seen in the left half of the curves in Fig. 1 were obtained, these lines representing an exponential relationship between stress and number of reversals. Below a certain unit stress, however, failure did not occur even at 100,000,000 cycles. In the neighborhood of a certain critical value quite variable numbers of cycles were obtained in different tests with substantially the same unit stress, as indicated in the plotted points in the first curve of Fig. 1. The phenomenon indicates the existence of a limiting stress defined by a sharp break in the curve from inclined to horizontal, below which stress the faitgue action which causes failure at higher stresses appears to be absent.

Curves of exactly this character were obtained for all of the tests (covering steel only). Seven of them are represented in Fig. 1, of which the last four represent typically consistent results, departing but little from the mean curve, while the first three contain somewhat

more erratic results. In the plots, each point generally represents a single test.

Fatigue Also Measured by Heating—Various other methods of measuring fatigue were tried, such as bending on an Upton-Lewis machine, reversed torsion on an Olsen-Foster machine and measuring the temperature rise produced by a very small number of repetitions. The last named method, worked out by J. W. Harsch and W. J. Putnam, gave very definite results as represented in Fig. 2, in which the abscissas, representing galvanometer divisions of a thermocouple current, represent a temperature rise after 30 sec. rotation of the loaded specimen at a speed of 1,000 r.p.m. (for the two right-hand curves in Fig. 2 the time of run was 2 min.). There is a sharp break in each of the curves of heating, unmistakably present, indicating a suddenly increased heat development when the stress applied in the reversals passes a certain value. The assumption that this limiting stress value corresponds with that obtained in the failure test is borne out by the tabulated figures and by the graphical comparison in Fig. 3, where the plotted curves for rotating beam endurance limit and heating endurance are seen to be in excellent agreement.

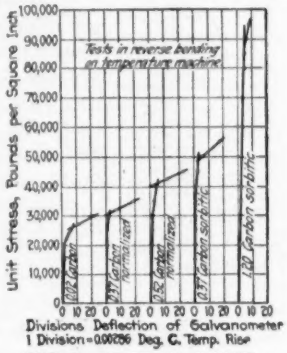


FIG 2. THE HEATING LIMIT OF STRESS REPETITION

In Fig. 3 are plotted also the curves for the other mechanical properties of the various metals tested. Except for hardness and ultimate tensile strength, they do not seem to be related to endurance; this applies to impact, repeated impact, and proportional elastic limit. The lack of any correspondence of these qualities with endurance, as contrasted with the close agreement of endurance with tensile strength and hardness, makes the two latter properties and the heating (which is determined by a test requiring only a few minutes) only the more significant as giving a simple index of endurance of steel to stress repetition or reversal.

Minor Influences on Endurance Limit—The experiments were so directed as to furnish also a few data on the influence of shape of test piece and surface finish on endurance limit. It was found that a semicircular groove of ¼-in. radius at the smallest part of the section reduced the strength about 8 per cent, square shoulders about 51 per cent, and a V-notch about 60 per cent. The effects on the softest steel and on fairly hard steels were quite similar.

Various degrees of ground and polished finish were tried in comparison. A high rouge polish gave only slightly higher endurance strength than the standard finish adopted for the main series of tests, while specimens with a ground finish were slightly weaker and smooth-turned specimens still weaker. The difference between rough-turned and rouge-polished specimens was about 18 per cent.

Overstress ranging from 10 to 35 per cent applied several hundred times (10 per cent overstress applied 5,000 times) did not affect the endurance limit appreciably, though 29 per cent overstress applied 5,000 times (the regular series of repetitions then following) reduced the endurance limit 11 per cent. This indicates that a few repetitions of relatively high stress preceding or interspersed among the regular repetitions of stress below or up to the endurance limit are of no significance with respect to the life of the piece.

Raising the elastic limit by cold working did have a slight effect on the endurance limit, both in the case of a 0.18 per cent steel and in the case of cold drawn screw stock of 0.20 per cent carbon; in the case of the latter the effect was noticed by slight reduction of the endurance limit by annealing. The effect of hardening and tempering appears to be represented quite accurately by the increase in tensile strength and hardness caused by the treatment. It follows that if a material is given a sorbitic structure by heat treatment its endurance limit may be greatly increased without much sacrifice of ductility.

The interesting fact is revealed by the figures that the endurance limit may be higher than the tensile elastic limit. This was observed most markedly in the case of the softest steel tested, a material which was almost pure ferrite.

Further work now under way in this fatigue investigation includes: (1) Work on stress repetition (as distinguished from alternation); several steels have already been tested, and there are indications that the results will be similar to those obtained for alternating stress, though showing a somewhat higher endurance

RESULTS OF ALTERNATING STRESS ENDURANCE TESTS ON STEEL

Steel	Tension								
	Set Elastic Limit	Proportional Elastic Limit	Yield Point	Ultimate	Elongation per Cent	Reduction of Area per Cent	Brinell Hardness	Endurance Rotating Beam Machine	Limit Heating Method
0.02 Carbon—as received	14,400	16,100	19,000	42,400	48.3	76.2	69	26,000	26,000
Hot-rolled, 0.18 C—as received	39,600	38,200	40,300	61,500	41.0	66.7	...	28,000	27,000
Reduced to 0.48 in.	60,100	60,000	63,300	67,600	22.3	63.3	...	35,000	38,500
Reduced to 0.44 in.	70,500	69,600	None	73,400	14.2	59.5	...	41,000	40,500
Bent cold and straightened	...	...	...	...	...	...	...	30,000	...
Cold-drawn, 0.20 C—as received	52,200	55,200	None	86,800	13.8	49.3	...	41,000	41,500
Annealed at 1300° F.	25,900	26,700	29,500	56,600	41.3	65.5	...	29,000	27,500
Annealed at 1550° F.	25,600	28,000	30,000	57,700	40.8	63.2	...	25,000	...
0.37 Carbon—Normalized	33,500	34,500	34,900	71,900	29.4	53.5	132	33,000	31,000
Sorbitic, Treatment A	82,000	80,600	87,300	102,600	23.3	65.1	209	57,000	...
Sorbitic, Treatment B	60,300	61,500	63,100	94,200	25.0	63.0	...	45,000	49,000
0.49 carbon—sorbitic	67,300	67,700	69,700	96,900	23.5	57.8	197	48,000	48,000
0.52 carbon—normalized	47,200	45,400	47,600	98,000	24.4	41.7	193	42,000	41,500
Sorbitic	79,400	80,300	84,300	111,400	21.9	56.6	227	55,000	53,000
0.93 carbon—pearlitic	25,500	28,000	33,400	84,100	24.8	37.2	162	30,500	28,500
Sorbitic	20,700	60,300	67,600	115,000	23.0	39.6	227	56,000	53,000
Troositic	102,200	97,200	None	188,300	9.9	29.3	380	98,000	90,000
1.20 carbon—normalized	59,100	58,600	60,700	116,900	7.9	11.6	224	50,000	43,000
Sorbitic	119,600	120,400	130,100	179,900	9.0	15.2	369	92,000	88,000
3½ nickel—treatment B	85,500	82,400	91,100	111,800	23.6	60.2	242	63,000	62,500
Chrome-nickel—treatment A	117,200	115,500	128,100	138,700	18.2	61.8	291	68,000	66,000
Treatment B	99,700	101,700	103,700	103,300	24.2	68.7	247	65,000	65,000
Treatment C	86,300	86,200	100,500	114,200	23.2	69.3	246	67,000	70,000

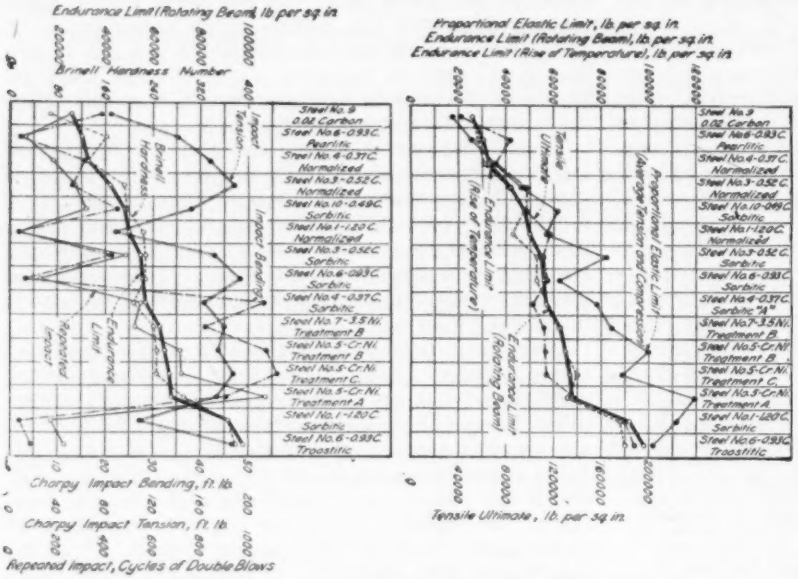

Endurance Limit (Rotating Beam), lb. per sq. in.
Brinell Hardness Number
Proportional Elastic Limit, lb. per sq. in.
Endurance Limit (Rotating Beam), lb. per sq. in.
Endurance Limit (Rise of Temperature), lb. per sq. in.
Tensile Ultimate
Endurance Limit (Rise of Temperature)
Endurance Limit (Rotating Beam)
Proportional Elastic Limit (Average Tension and Compression)
Charpy Impact Bending, ft. lb.
Charpy Impact Tension, ft. lb.
Repeated Impact, Cycles of Double Blows
Tensile Ultimate, lb. per sq. in.

FIG. 3. ENDURANCE LIMIT PARALLELS VARIATION OF ULTIMATE STRENGTH AND HARDNESS

limit. (2) Apparatus for tests in reversed torsion and in reversal of direct stress (tension and compression) is being developed. (3) The investigation is being extended to some non-ferrous metals and to a fuller study of heat treatment.

Sydney Harbor Cantilever Bridge Design

ACCORDING to the official design for the proposed Sydney Harbor bridge, connecting Dawes Point on the south and Milson's Point on the north, a cantilever structure with a main span of 1,600 ft. c. to c. piers and a width of 98½ ft. between truss centers is required. The suspended span is to be 600 ft. long and the cantilever arms 500 ft. each; the anchor arms being of the same length as the cantilever arms, the total length of the cantilever structure between centers of anchorage becomes 2,600 ft. There is an approach at either end of three spans of about 200 ft. each. The total length of the steel structure is 3,816 ft.

Rock is at relatively shallow depth at all the pier sites. The main piers require to be built in tight cofferdams (or by compressed air), but the excavation for the anchorages and approach piers is entirely above sea level and should cause no difficulties from water.

The main cantilever structure, which is to have a clearance height of 170 ft. above high water at mid-span, has a straight bottom-chord line, following the side gradients of 2½ per cent merging into the level line of the suspended span. The trusses are 270 ft. deep at the piers, and 100 ft. deep throughout the length of the suspended span; the top chord drops from the tops of the main posts to tangency with the central portion along a parabolic arc, and in somewhat similar outline, but with a circular arc, to the tops of the end batter posts over the anchorages. There are only two trusses. The web system is subdivided Warren, with main panels of 200 ft. adjacent to the piers and 150 ft. elsewhere, each subdivided into four sub-panels by means of main verticals and a sub-post system. The roadway is to consist of a railway section carrying four tracks spaced 12 ft., and a 35-ft. highway section protected on each side by a steel balustrade. Outside the main trusses, carried on floorbeam cantilevers, there is to be an 18-ft. motor roadway on one side and a 15-ft. footway on the other.

Four lines of trusses are used in the approach spans. These are deck trusses, also of the subdivided Warren type, with four sub-panels per main panel. Here as well as in the main span the motor roadway and footway are carried on floorbeam extensions.

Alternate designs may be offered by bidders, according to the call for bids. The plans prepared by the chief engineer, J. J. C. Bradfield, must be followed in their salient features, but length of spans, outline of trusses, web system, and other features may be changed for the sake of economy and improved appearance. No limitation is made as to the grade of steel to be used or the design details. Bids must be delivered to the under secretary for public works at Sydney by Oct. 31.

Bronze Versus Steel as Material for Waterwheel Buckets

IN THE early days of hydro-electric development the buckets used in impulse waterwheels were usually made of bronze. Now the majority of impulse wheels are being equipped with steel buckets. Reasons cited by Western engineers in explanation of this apparent change in standard practice are as follows:

The average size of impulse units built ten or twelve years ago was comparatively small; the usual requirements for buckets being such as would best suit jets 2 or 3 in. in diameter. Because of rapid cooling of metal in molds, it was hard to get first-class steel castings in such small sizes and the high percentage of rejections on account of poor castings made bronze buckets considerably cheaper than steel.

The trend toward larger sizes in recent years is shown by the fact that impulse wheels recently built are driven by jets 10 or 11 in. in diameter and have buckets 28 to 30 in. wide that weigh up to 2,200 lb. apiece. In these large sizes the average of steel castings is greatly improved and because the present steel bucket will outwear the bronze bucket, steel has become the more satisfactory material and is also considered cheaper in the long run.

One Reclamation Project Pays Up

The sixth building installment was due the U. S. Reclamation Service on Dec. 1, 1921, by the Orland Unit Water Users' Association. It paid all of the $44,388.63 except $3,741.54 on time. Practically the whole amount was collected and paid by Jan. 1. When so many projects are clamoring for a suspension of payments the record established at Orland is considered especially gratifying to the Reclamation officials.

Draft-tube Back Pressure Cured at Roosevelt Power Plant

Tail-Race Discharge From Exciter Units Set Up Pressure in Main Unit Draft Tube in Same Tunnel Opening

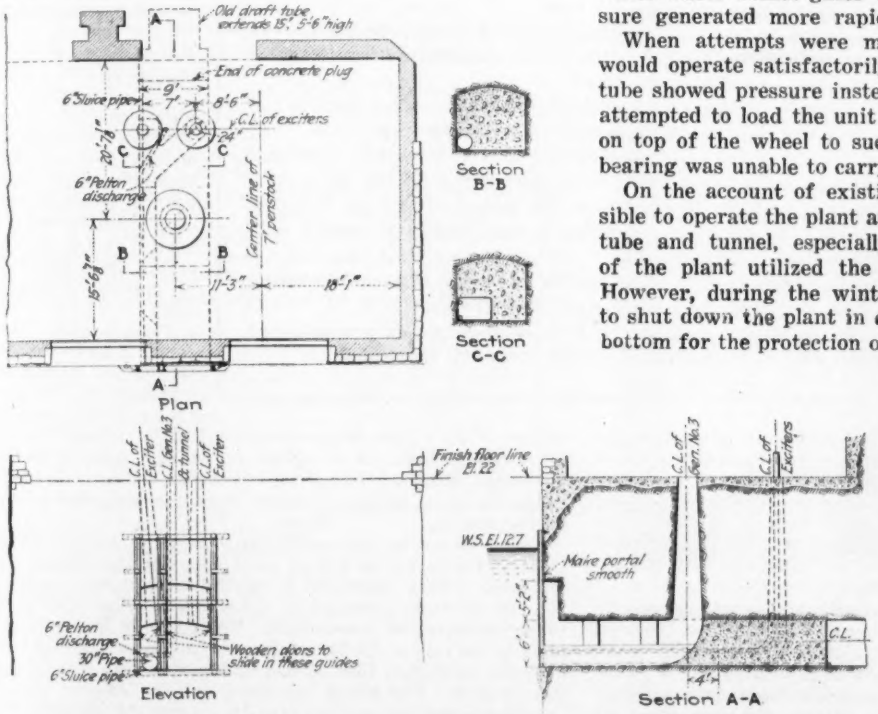
By C. C. Cragin

General Superintendent and Chief Engineer, Salt River Water Users' Association, Phoenix, Ariz.

At the water-power plant located at the Roosevelt Dam a peculiar back pressure in the draft tube of one of the vertical water-wheel units developed which, due to bearing trouble, has kept the unit out of commission most of the time since its installation.

The conditions as they existed were about as follows:

This draft tube discharged vertically into a tunnel which also carried to the tail race the discharge from two exciter unit water wheels, two small Pelton wheels driving oil pumps and also the drainage from the sides of the cliff into which the power plant was partially built. All of these discharged into the tunnel back of main unit draft tube. The water discharged from the Pelton wheels and the drainage discharged from the cliffs had considerable fall into the tunnel through pipes and both carried considerable air into the water in the tunnel.



DETAILS OF REPAIR WORK ON DRAFT TUBE AT ROOSEVELT DAM POWER PLANT

With the main unit standing idle and the gate to the water-wheel case closed, an air pressure would build up in the wheel case which reached a maximum of about 15 lb. per sq.in. When the air was allowed to escape through a 2½-in. connection, then water from the draft tube would flow continuously through this pipe. If the manhole cover on the water-wheel case located at the level of the wheel was removed, water would pour out of the manhole for several hours gradually falling off in amount until it ceased. The tail-water level was about 9 ft. below the bottom of the wheel, and the total vertical height of the draft tube above the tunnel roof was about 20 ft.

The action that was evidently going on was about as follows: The drainage discharge conduits which entered the tunnel at an angle of about 75 deg. to the horizontal was probably not filled with water and consequently the water that was flowing therein at high velocity was carrying large quantities of air into the tunnel. Also the discharges from the two small Pelton wheels were carrying considerable quantities of air, as was evidenced by a suction around their bearing housings, the tail-water conduits being enclosed. This air entered the tunnel, then, about 12 ft. back of the main unit draft tube. The tunnel roof being level, this air probably moved slowly along it and probably collected in large bubbles and rose in the main unit draft tube which was the first opening in the tunnel roof to be encountered. The continuous collection of air and the surging of the water due to wave action and probably other conditions inside the tunnel caused the compression of the air and the support of the water column in the draft tube even after the top of the draft tube was partially open to the atmosphere when the manhole cover was removed. Under this latter condition it is probable that the water-wheel wicket gates were closed so that the pressure generated more rapidly than it was discharged.

When attempts were made to operate the unit it would operate satisfactorily without load but the draft tube showed pressure instead of vacuum. When it was attempted to load the unit the pressure would build up on top of the wheel to such an extent that the thrust bearing was unable to carry the load.

On the account of existing conditions it was impossible to operate the plant and do any work on this draft tube and tunnel, especially because the exciter units of the plant utilized the same tunnel for discharge. However, during the winter of 1920 it was necessary to shut down the plant in order to do work in the river bottom for the protection of the Roosevelt Dam. At the same time this tunnel was reconstructed, and the discharge from each of the separate sources using the tunnel was brought to the tunnel portal in separate conduits. The main unit draft tube was connected into the tunnel with gradually curved surfaces. In order to do this work it was necessary to construct a coffer-dam in front of the tunnel portal, as the leakage from the reservoir was in excess of the pumping capacity installed for unwatering. The coffer-dam was constructed of lumber forms and concrete as the bottom was rough rock through which it was impossible to drive piling. The tunnel was unwatered by a motor-driven pump. Stop-log slots were constructed at the tunnel portal for future use.

Since completion of the work the unit has operated satisfactorily for nine months with a vacuum of approximately 10 in. of mercury.

Paving Slab and Subgrade Studies in Illinois

Rational Design of Rigid Slab Roads Made Possible by Research Conducted During Two Years by the Division of Highways—Abstract of Paper Before State Highway Officials Association

BY CLIFFORD OLDER
State Highway Engineer, Springfield, Ill.

SINCE October, 1920, ten investigators have been engaged in research work for the Illinois division of highways. Investigations have been made of (1) subgrade moisture; (2) subgrade bearing power; (3) subgrade uniformity; (4) frost action; (5) temperature effects; (6) impact; (7) repeated loads and (8) position of load for maximum stress. Based on the results *a rational method of designing paving slabs has been arrived at.*

Subgrade Moisture:—Fig. 1 is the moisture content curve of the subgrade of the Bates Road (*Engineering News-Record*, Aug. 18, 1921, p. 214) expressed as a percentage of the dry weight of the soil, which is the brown silt loam of the Mississippi valley corn belt, a finely divided material that ordinarily would be called a clay soil. The moisture content of the soil in proximity to edges and cracks was at no time materially different from that observed elsewhere. At a point where a tile drain, with a cinder backfill, was laid 30 in. below each edge of the pavement for a distance of 200 ft., the moisture samples show no variation from those obtained elsewhere. A trench about one foot from the edge of the pavement, leaving the shoulder undisturbed between the edge of the trench and the slab, was kept filled with water for three weeks. Although the nearest sampling stations were only 30 in. from the edge of the trench, the moisture content of the subgrade at these stations showed no increase and no variation from that at other points under the pavement.

TEST FACTS THAT AFFECT DESIGN

1. The moisture content of subgrade soil is only slightly influenced by the proximity of cracks and joints in the slab or by drains or by ponding.

2. A soil, for a given moisture content, under repeated loads, has a fairly definite elastic limit—for saturated Illinois soil it is less than 1 lb. per square inch.

3. There is continually a separating and a coming together of the slab and the subgrade owing to movements of both.

4. Under frost action—heaving due to freezing—the slab edges rise faster and more than the center of the slab.

5. Under temperature action the slab curls up or down at the edges, the action being periodic, sufficiently to render subgrade support ineffective.

6. Slab corners formed by cracks or joints, to resist breaking must be designed as unsupported cantilevers.

7. Slabs designed to carry maximum loads at unsupported right-angled corners are of ample strength throughout.

Blocks cut out of the subgrade so as not to disturb the natural compaction and then frozen and thawed out, were immersed in water; most of them fell to pieces upon immersion. Samples not frozen remained practically intact and absorbed moisture slowly. From these tests, it seems that although a clay subgrade may resist, markedly, saturation from an occasional rain fall, yet the same soil may quickly become saturated after a freeze.

Subgrade Bearing Power:—An apparatus was devised by which loads up to 50 lb. per square inch could be repeated indefinitely on subgrade soils in place. The results point strongly toward the conclusion that a soil, having a given moisture content, may under repeated loads have a fairly definite elastic limit. This for Illinois soil containing at times 40 per cent moisture is very low, probably less than 1 lb. per square inch.

The general behavior of subgrade soils as determined on small areas by this machine were closely confirmed by loading concrete slabs having areas of several square feet, which were cast on the same subgrade; the first few light loads caused permanent depressions.

Different points on the same subgrade soil, although having the same moisture content, did not exhibit uniform results. This is considered to be due most likely to inequalities in compaction.

Subgrade Uniformity:—There were installed in the Bates Road many subgrade cylinders each having a brass disk in contact with the subgrade, and a reference plug screwed in the cylinder in such a manner that measurements taken from the plug to the brass disk would show the relative position of the subgrade and the pavement slab at any time. Readings were taken once each week. They show distinctly a periodic separation of the pavement slab and the subgrade due to the warping of the slab under temperature changes. They show, also, to a very marked extent erratic variations due in all probability to uneven settlement of the subgrade due to uneven compaction. Some show a separation of as much as ½ in. over areas of considerable magnitude. At practically all a separation has occurred at one time or another.

Frost Action: Observations of frost heaving on the Bates Road were made during the winter of 1920-21. Precise levels showed a heaving or lifting of the edges of the slab throughout the entire length of the road, at a much more rapid rate than at the center. On sections where a longitudinal joint was provided, the edges of the pavement slabs lifted about ¾ in., while the center lifted about ¼ in. Many sections not provided with longitudinal joints showed approximately the same behavior; all such sections when examined in the spring were found to be cracked longitudinally.

Temperature Effects: Tests undertaken to determine whether or not the subgrade under a corner of a slab would be compressed under repeated loads to such an extent as to afford no definite support to the pavement, disclosed that at night the slab corner under load might be at a higher elevation than the unloaded corner during the day.

Fig. 2 shows the air temperature and the vertical movement of the corner of a 9-in. plain concrete slab loaded and unloaded. This diagram is typical of several hundred. Hourly elevation readings to thousandths of an inch were taken by means of Ames dials. The 6,000-lb. load was applied to the corner for three minutes each hour. Under this load the computed fiber stress in the slab was 220 lb. per square inch. For about two-thirds of the 54-hour period the 3-ton load did not depress the corner to its unloaded afternoon position. It is obvious that the subgrade offered but little if any support for two-thirds of the time.

Fig. 3 shows the curvature of a 7-in. slab on a line bisecting the corner angle. The upper solid line, diagram A, shows the upward warped position of the surface of the slab along a 45 deg. line from the corner to the center of the pavement. The upper dashed line shows the position of the slab while a load of 6,000 lb. was applied on an area of 2 sq.in. at the corner. The lower solid lines show the position of the unloaded slab at the point of maximum downward deflection. The lower dashed line shows the position of the slab under the 6,000 lb. load when applied during the

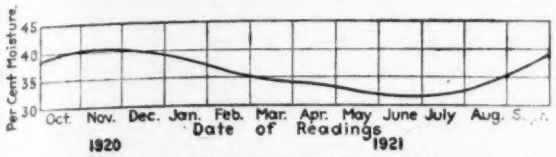


FIG. 1. SUBGRADE MOISTURE CURVE, BATES EXPERIMENTAL ROAD

day. It is obvious that the slab corner acted purely as a cantilever in supporting the night load. It is also obvious that, as the increased deflection was not as great when the load was applied during the day as when applied at night, subgrade support had some influence on the amount of deflection. The computed fiber stress of the concrete, considering the corner as a cantilever under the night load,

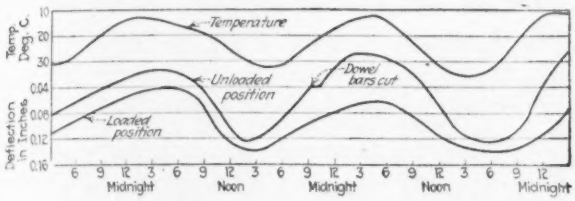


FIG. 2. DAILY VARIATION IN DEFLECTIONS OF SLAB CORNER UNDER LOAD

amounts to 368 lb. per square inch which is certainly not too low for the working stress of plain concrete. It is obvious that a much greater load with a correspondingly high fiber stress would be required to deflect the corner to contact with the subgrade at night.

Diagram B, Fig. 3, shows the effect under similar conditions of a longitudinal crack or joint. The warping effect does not pivot about the center of the half slab as defined by the longitudinal joint. Even in this case the upward warping of the slab due to temperature effects was greater than the downward deflection of the slab, under the 6,000 lb. load producing a fiber stress of 368 lb. per square inch.

Fig. 4-A shows the edge of an 8-in. pavement slab and the subgrade below. The white card on the left is rigidly attached to the slab. The card at the right is fixed to the subgrade at some distance below the base of the pavement.

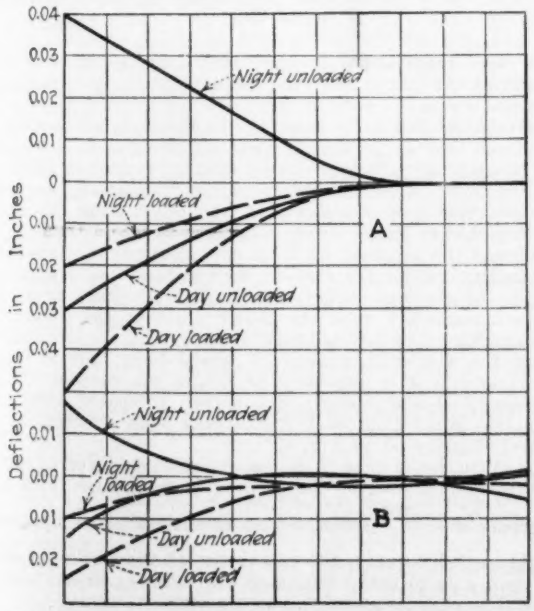


FIG. 3. CURVATURE OF SLAB ON LINE BISECTING CORNER ANGLE

The black line was drawn across the two cards at mid-day while the sun was shining. Fig. 4-B taken at midnight, shows a distinct crack in the earth subgrade a short distance below the bottom of the pavement; and shows the offset in the line caused by the upward movement of the slab. A load of four tons on the edge of the pavement failed to close the offset or the visible crack in the subgrade.

By means of the brass disks of the subgrade cylinders located in a row across the pavement slab, the relative movement of the slab and the subgrade was confirmed. In many cases these measurements indicated positively that the downward curling of the edges during the day lifts the center of an unbroken slab entirely free from the subgrade

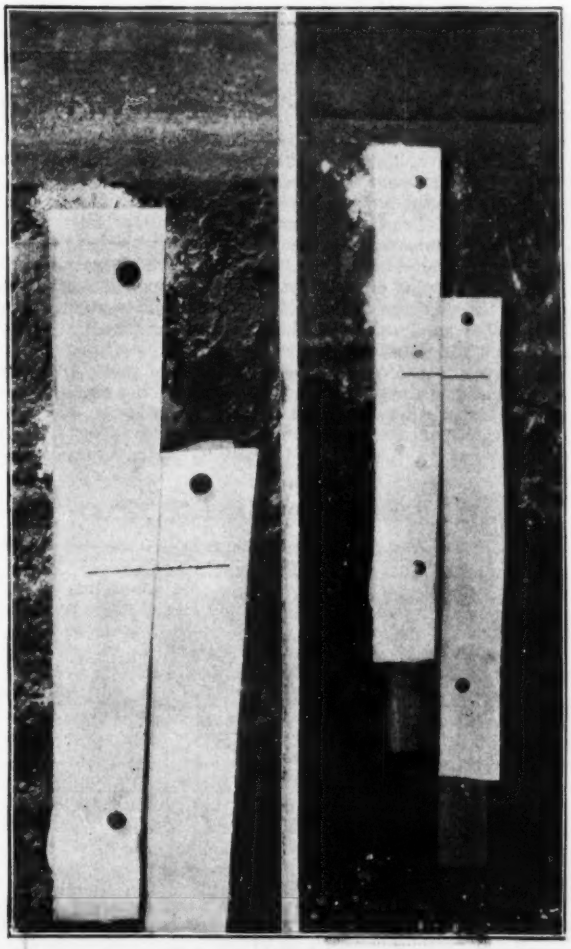


FIG. 4. OFFSET IN MARKED LINE SHOWING LIFT OF SLAB EDGE

near the center. They indicate also a permanent depression of the subgrade at the edges of the pavement under this condition, although a partial recovery occurs as the edges curl up at night.

Monolithic brick pavements exhibit practically the same degree of warping as concrete slabs. The effect is much reduced when a bituminous concrete surface is applied. It is similarly reduced when a brick wearing surface having a bituminous jointfiller is used on a concrete base. Fig. 5 shows the edge movement of various slabs. All readings were taken practically simultaneously for 24 hours.

Special attention is called to the slight warping of slabs having plastic surface materials of considerable thickness. Attention is also called to the comparatively small warping of the concrete slab having a longitudinal joint.

Warping of rigid slabs away from the subgrade provides

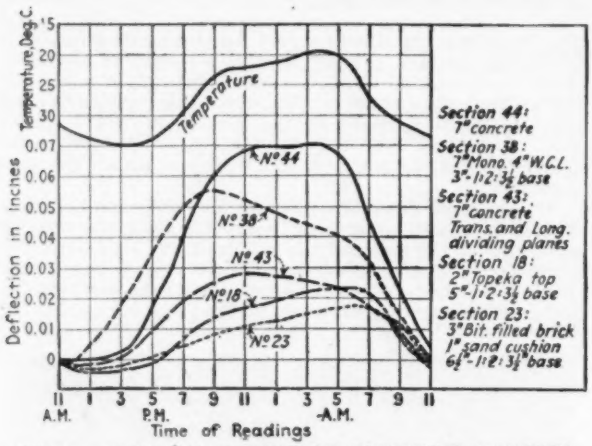

Temperature, Deg. C.
Deflection in Inches
Temperature
No. 44
No. 38
No. 43
No. 18
No. 23
Section 44: 7" concrete
Section 38: 7" Mono. 4" W.C.L. 3"-1:2:3½ base
Section 43: 7" concrete Trans. and Long. dividing planes
Section 18: 2" Topeka top 5"-1:2:3½ base
Section 23: 3" Bit. filled brick 1" sand cushion 6½"-1:2:3½" base
A.M. P.M. A.M.
Time of Readings

FIG. 5. EDGE MOVEMENTS OF VARIOUS PAVEMENTS

open channels for the free passage of surface water to all parts of the subgrade. This was observed many times. Throughout the year with distressing regularity, free water was found in the subgrade cylinders after heavy rains.

Position of Loads for Maximum Stresses: Fig. 6 indicates conditions which may apply along the edges of a pavement slab. Diagram A represents the deflection readings of an Ames dial placed at the edge of the pavement during the passage of a four-ton wheel load along the edge of the slab as close to the dial as feasible. The dial in this case was placed at some distance from the nearest transverse crack. It is of interest to note the shape of the curve showing the deflection of the edge at the dial as the wheel passed and the total amount of this deflection.

Diagram 6-B shows the curve of deflection when two dials were placed on the corner formed by a transverse crack.

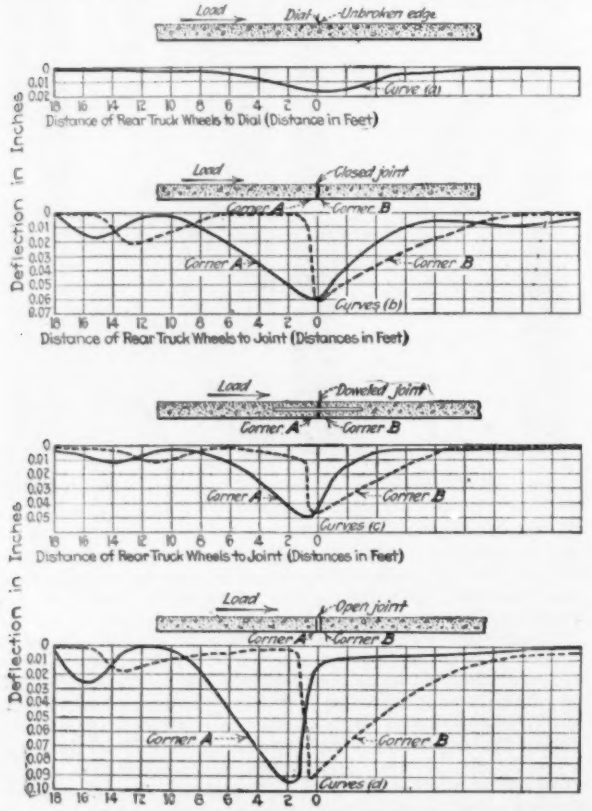


FIG. 6. DEFLECTION OF DIFFERENT JOINTS UNDER MOVING LOAD

In this case the crack was very fine, the observations having been made during a period of high summer temperature when the slab was expanded and apparently all cracks closed very tightly. Note that the total deflection is much greater than shown in Diagram A, although it is apparent that the closed crack prevented each corner from acting independently. Diagram C shows a similar condition in which, although the crack was open, short dowell bars passed across it. Note that the deflection is approximately the same as that which occurred at the closed crack.

Diagram D shows the very marked effect occasioned by an open crack or joint with no dowell bar or other means for causing both corners to act together. Deflections of the center of a slab under load were two small to be platted to this scale. While deflections only are platted in these diagrams, yet strain gauge measurements show the same proportionate results. As stresses are in proportion to strains the position of loads to produce maximum slab stresses are easily apparent from these diagrams. All of these deflections are platted from observations on slabs of

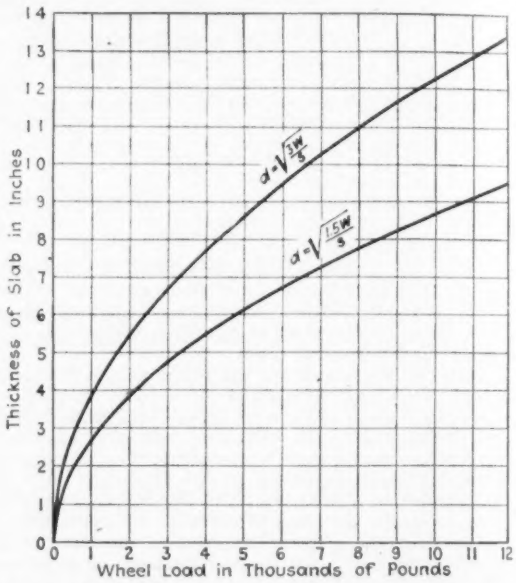


FIG. 7. REQUIRED SLAB THICKNESS FOR DIFFERENT LOADS

the same thickness and taken during the night when the edges of the pavement were not in contact with the subgrade.

Design of Rigid Pavements: In the light of conclusive evidence that an uncovered rigid slab may become warped by temperature effects so that it will, for from 8 to 12 hours out of every 24, be completely unsupported along the edges by even the best of subgrades, and considering the probability that at least on clay subgrades at certain seasons of the year the soil may have an exceedingly low supporting capacity, and further considering the fact that during the period of greatest subgrade saturation which no doubt occurs immediately upon the thawing out of the ground in the spring when low temperatures prevail, the cracks are open the maximum amount, *it would seem that to resist local breaks it is necessary to design the corners of the pavement as unsupported cantilevers.* Unbroken edges are far less susceptible to traffic breaks than corners, as is clearly illustrated by Fig. 6.

It is the belief that if the pavement be designed to carry the maximum load at the corners in accordance with the formula $d = \frac{3W}{S}$ which covers conditions at unsupported right-angled corners, the remainder of the pavement will be well able to carry the same load without breaks which would damage its usefulness as a pavement surface.

If means could be found to make both corners act to-

gether by placing longitudinal shear bars along the edges of the pavement, or by some other means and the corner weakness thus be reduced by one-half, the design formula $d = 1\frac{1}{2}W/S$ could be used with a reasonable degree of safety.

In order that all possible corners might be taken care of, it is believed that the position of the longitudinal crack should be controlled by constructing a longitudinal joint and the adjacent slabs held in close contact by transverse tie bars. The interior corners, being held in close contact along the longitudinal joint by the transverse tie bars, should be fully as safe as the edge corners. The shear bars along the edges should also be continuous in order to take care of corners formed by transverse cracks regardless of their position.

Fig. 7 shows the thickness of slab required if designed in accordance with the formulas heretofore given, assuming a safe working stress for 1:2:3½ concrete in tension of 200 lb. per square inch. The upper line is platted from the formula $d = \frac{3W}{S}$ and the lower line the formula $d = \frac{1\frac{1}{2}W}{S}$. The result of our fatigue tests although not yet complete seems to indicate that a working stress higher than 200 lb. per square inch may be safe for concrete of the quality ordinarily used in road construction.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Turkey Creek Sewer Design

Sir—In an exceedingly interesting description of the Turkey Creek Sewer, in the *Engineering News-Record*, Nov. 17, page 825, I was greatly surprised to note the method of design of the box section. To quote the author of the paper: "The top and bottom were each assumed to act as a continuous beam of two spans. * * * Side walls were computed as a simple beam * * * "

Why was the section analyzed along such lines, when the complete analysis of the box section could easily have been obtained and would give results much more consistent than those obtained by the methods used? Thus the effect of the loading on the roof is carried into the side wall and conversely. It seems strange to think that more exact methods were not followed since the proper reinforcing of the rigid box is vitally dependent upon the computation of all the moments and not only upon those obtained by breaking up the box into separate units.

Bulletin 8 of the Engineering Experiment Station, University of Illinois, has completely analyzed the stress system in various types of frames and its seems both a matter of economy and of efficient design to employ the results conveyed in the *Bulletin*.

GEORGE PAASWELL,
New York, Nov. 19, 1921. Consulting Engineer.

[This letter was submitted to Mr. Ludlow, who has reported as follows.—EDITOR.]

Sir—Among the many bulletins of the University of Illinois in my library I fail to find *Bulletin 8*, and acording to the list of bulletins in their more recent publications it is marked "none available." I was also unable to find it at our public library so that I do not know to what Mr. Paaswell refers.

Without knowing what the method is of which he speaks I have no doubt that it was used as the structure was analyzed by all the methods that seemed at all applicable and the results compared.

Before the section shown was finally adopted it was submitted for checking as to strength to the engineering departments of the various railroads under which the sewer will pass and was approved by all of them. As they were interested both in getting a structure of ample strength and at the same time in keeping down the cost so as to make the amount they would have to pay as small as possible it is evident that their methods of analysis, whatever they were, must have agreed closely with my own.

I regret that I cannot at this time furnish Mr. Paaswell with a comparison of results obtained by the method criticised and the various other methods used. When I severed my connection with the sewer division of Kansas City 2½ year ago, I left all these calculations in the office and have none of them in my possession at this time.

Kansas City, Dec. 10, 1921. A. D. LUDLOW,
Consulting Engineer.

Strength of Suspension-Bridge Cable Wire Definitely Known

Sir—The Delaware River Bridge Joint Commission recently made a highly important and far-reaching decision relative to the construction of the new Philadelphia-Camden suspension bridge. Acting on the report and recommendation of the chairman, Ralph Modjeski, the commission unanimously decided that the cables of this bridge should be made of parallel, galvanized wires with independent suspended stiffening trusses rather than of eyebars or any other form of cables. This decision was based first on past experience in the use of wire cables for long-span suspension bridges as exemplified in the Niagara, Brooklyn, Williamsburgh and Manhattan bridges as compared with the experimental character of eyebar cables, and second on the comparative cost, which is estimated to be for wire cables about one half that of eye-bar cables.

To this might be added another reason which was no doubt considered by the board (though not mentioned in the press report of their decision) and which appears to the writer to be of great importance, namely that the strength and properties of a wire cable are much more accurately known than is possible in any other form of cable. In ordinary structural steel work one or more tests are made on the finished material from each heat of steel and it is assumed that all the rest of the steel from this heat will develop results substantially the same. Steel from the same heat, however, may be and often is reheated at different times and sometimes at different places and may be rolled into different forms, with the possibility, notwithstanding every known precaution, that the finished material may vary considerably from the sample tested owing to different heat treatment or rolling conditions. A full-size test is also often made, particularly in the case of eyebars, and it is assumed that similar full-size members will give results similar to this test. Thus the strength and characteristics of the material in all ordinary steel construction as far as can be known are based on assumptions; reasonable and probable, to be sure, but assumptions nevertheless. And there is no known way to do otherwise. With wire cables, however, it is different. Aside from the fact that wire-drawing in itself is a good test of every inch of the steel and that any material oversight or error in heat treatment, annealing or mechanical operation is pretty sure to be disclosed by the breaking of the wire in drawing, we have besides the evidence of two tests made on every coil, one from each end, where it is known as the result of a great number of experiments that the wire is always poorest. And these tests are made after all heating, mechanical processes and annealing are finished and the wire is ready to go into the cable. In other words, in a wire suspension bridge we have the record of two full-size tests on every individual wire in the cables. Our knowledge of the strength and characteristics of the material in a wire cable therefore approaches more nearly absolute certainty than is possible in any other form of steel construction.

CHAS F. STOWELL,
Albany, N. Y. 68 State St.
Jan. 4.

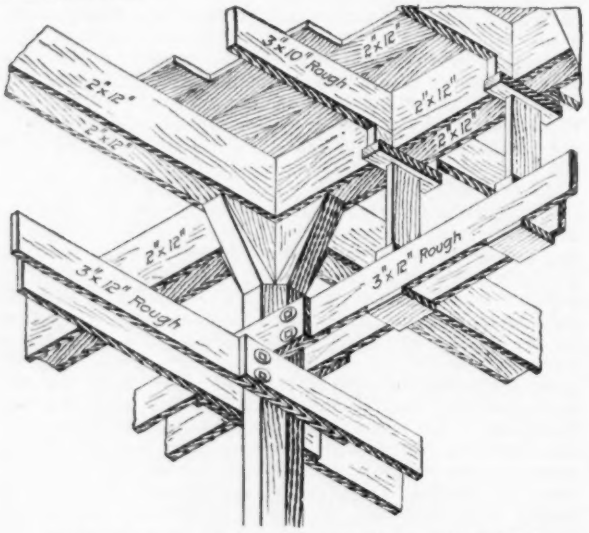
[Criticisms of wire cable construction have not questioned the strength of the wire, but only the definiteness of knowledge concerning the strength secured in assembling the wire in a large cable.—EDITOR]

HINTS FOR THE CONTRACTOR

Pile Braces and Staging for Forms Combined on Manila Pier

By H. H. Braun
Engineer Constructor, Manila, P. I.

A MOST satisfactory set of forms was used in building a large concrete pier which has just been finished in Manila Bay. The structure is a slab and girder deck founded upon precast concrete piles. As indicated by the sketch, 3 x 12-in. pieces, which are bolted to the piles, furnish a framework to hold the piles on centers; give intermediate support to the beams; support the haunch forms, and furnish a working platform.



PILE BRACE AND FORM SUPPORT COMBINED

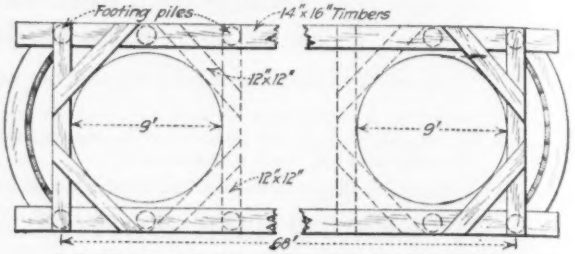
Few things in concrete wharf buildings are more difficult or more necessary than to locate and drive the piles in their exact position, particularly if the penetration is deep in firm bottom, and the distance from the bottom to the deck be small. If the water is deep considerable play can be had by springing the piles. Owing to the hard bottom and rough water at the site it was particularly difficult to drive the piles true to center.

The piles were driven in succession from the shore outward, and immediately braced by bolting on a pair of 3 x 12-in. plank, both in a longitudinal direction and across the bent. When a pile was found to be the least bit out of center, as was the case with most of them, a line was snubbed to the pile head, rove through a snatch block attached to the adjacent braced piles, and pulled by the "nigger head" on the pile driver. A steady strain, assisted by vigorous jetting quickly centered the post. It was then braced by the 3 x 12-in. plank placed just below the level of the haunches.

As all the panels were uniform throughout, the forms were made in sets which could be quickly stripped and re-erected. Each set of pile bracing and forms were used four times. The details of the bracing and form work are shown by the drawing.

Timber Frame Resting On Piles Guides Pier Cylinders in Sinking

PIER cylinders used in the construction of the Long Beach bridge, a highway structure of steel spans encased in concrete and which connect Wreck Lead with Long Beach, Long Island, were sunk to their exact positions with the use of a heavy timber frame which rested upon the tops of the footing piles.



TIMBER FRAME FOR PIER CYLINDER SUPPORT

As shown in the accompanying sketch the timber frame was made of 14 x 16-in. timbers longitudinally placed and 12 x 12-in. timbers forming the cross and diagonal bracing. The frame was just wide enough to rest on the pile centers and long enough so that the two cylinders could be sunk into place with the same frame. Steel sheetpiles of an approximate length of 65 ft. and weighing 45 lb. to the foot was driven against the end of the frame in the arc of a circle so that the bell ends of the cylinders in sinking were flush against the piles.

Those parts of the frame indicated in the sketch by dotted lines were set in place and bolted only after the first section of cylinders had been sunk. This procedure was necessary because of the greater diameter of the bell ends of the cylinders.

As the cylinders were lowered, sections were riveted on at about the level of the timber frame. The cross-braces of the frame came in contact with the cylinder as it went down and allowed the cylinder to be suspended while additional sections were placed. When the cylinders were sunk they were jetted into final position.

The work was done by the McLean Contracting Co. of Baltimore. The bridge is being built by Nassau County, New York, with W. Fred Starks in charge as county superintendent of highways.

Strength of Manila Rope from New Tests

From a series of 368 tests of Manila rope in sizes from $\frac{1}{4}$ in. to $4\frac{1}{2}$ in. diameter carried out at the Bureau of Standards during the past three or four years (reported in Technologic Paper 198) it has been found that the average breaking strength of the rope is very closely represented by the formula $L = 5{,}000\ d(d + 1)$. The minimum and maximum strengths that may be expected in such tests correspond to a range of the coefficient in this formula from 3,700 to 6,300. Tests of "hard-laid" rope were included in the series; no separate figures for the strength of this kind of rope are given, but its stress-strain curve is stated to be concave to the load axis, the rope showing decreased rate of stretching as the load on it increases.

NEWS OF THE WEEK

New York, January 12, 1922

"Transportation" Is Feature of Am. Soc. C. E. Meeting

Technical Program Provides for Many Addresses by Members and Non-Members

Supplementing the general outline of the program for the annual meeting of the American Society of Civil Engineers, to be held in the Engineering Societies Building, New York City, Jan. 18-20, as announced in this journal Jan. 5, p. 34, the following list of speakers and subjects for the technical sessions dealing with the general topic "Transportation" has been issued by the acting secretary of the society:

Jan. 19 at 9:30 a. m. Subject, "Water Transportation." Speakers:

Dr. Emory R. Johnson, Dean, Wharton School of Finance and Economy, University of Pennsylvania, Philadelphia, Pa.; R. H. M. Robinson, president, United American Lines, New York; Winthrop L. Marvin, vice-president and general manager, American Steamship Owners' Association, New York; Samuel O. Dunn, editor, *Railway Age*, Chicago, Ill.

Jan. 19, at 2 p. m.—Subject, "Railroad Transportation." Speakers: Howard Elliott, chairman, Northern Pacific Ry. Co., New York; George W. Simmons, vice-president, Simmons Hardware Co., St. Louis; William N. Doak, vice-president, Brotherhood of Railroad Trainmen, Washington, D.C.; Col. F. A. Molitor, chairman, Board of Economics and Engineering, National Association of Owners of Railroad Securities, New York; Edgar E. Clark, formerly chairman, Interstate Commerce Commission, Washington, D. C.

Jan. 19 at 8 p. m.—Address, "World Activities and their Effect Upon the Engineer," by Frank A. Vanderlip, formerly president, National City Bank, New York, (to be followed by Smoker.)

THREE HIGHWAY SESSIONS

Jan. 20 at 9:30 a.m.—Subject "Highway Transportation." Speakers on "Inspection": Thomas H. MacDonald, director, U.S. Bureau of Public Roads, Washington, D.C.; Fred W. Sarr, first deputy, Commission of Highways, Albany, N.Y.; Col. William D. Uhler, chief engineer, State Highway Department, Harrisburg, Pa.; William G. B. Thompson, formerly state highway engineer, Trenton, N. J.; Paul D. Sargent, chief engineer, State Highway Commission, Augusta, Maine.

Jan. 20, at 2 p.m.—Subject "Financing and Bonding." Speakers: John N. Cole, commissioner, State Department of Public Works, Boston; Robert S. Parsons, general Manager, Erie Railroad Co., New York; Jeremiah C. Finch, secretary, Commission of Highways, Albany, N. Y.; E. A. St. John, vice-president, National Surety Co., New York; Edward C. Lunt, vice-president, Fidelity and Casualty Co., New York; Frederick Stuart Greene, formerly commissioner, Commission of Highways, New York; Harry Meixell, Jr., secretary, Motor Vehicle Conference Committee, New York.

State Sues to Compel Trenton, N. J., to Build Sewage-Works

On behalf of the State Department of Health the Attorney-General of New Jersey has applied for an injunction against the City of Trenton, N. J., to prevent the discharge of untreated sewage into the Delaware River. The city was ordered several years ago to build sewage-works.

Two More Muscle Shoals Offers Are Made

In addition to the proposition for the completion of the Wilson dam and appurtenances at Muscle Shoals on the Tennessee River, made some time ago by Henry Ford, two other offers have been made to the government. The first is by the Construction Co. of North America, which is now building the Hetch Hetchy tunnel aqueduct for the San Francisco water supply. This company offers to complete the dam, power house and appurtenances, maintain the auxiliary steam plants, build new dam No. 3, and operate the nitrate plants, if the government decides they can be operated successfully in competition with other sources of supply. The company proposes to finance the project by issuing bonds to be bought at par by the government and to be paid back out of the earnings within 25 years. The leasehold would be for 50 years with option for another like period.

The other proposal is from Frederick E. Engstrum, of Wilmington, N. C. This is also for a 50-year lease with large privilege of control by the government but provides that the operating company shall be paid $36,000,000.

Secretary of War Weeks is reported to have said that the Ford offer is the only one which gives proper provision for future operation of the nitrate plants.

Jan. 20, at 8 p. m. — Subjects "Administration," "Relation of Highway to Other Transportation Systems," "Motor Vehicle Control." Speakers: Lewis S. Sadler, commissioner, State Highway Department, Harrisburg, Pa.; William D. B. Ainey, chairman, Public Service Commission, Harrisburg, Pa.; Herbert S. Sisson, commissioner, Commission of Highways, Albany, N. Y.; John N. Mackall, chief engineer, State Roads Commission, Baltimore, Md.; Harry Meixell, Jr., secretary, Motor Vehicle Conference Committee, New York.

HONORARY MEMBERSHIPS

At the morning session of Jan. 18 honorary membership in the Society will be conferred on Charles Prosper Eugene Schneider, Paris, France; Luigi Luigi, Rome, Italy; Samuel Rea, New York; Ambrose Swasey, Cleveland; and Howard A. Carson, Boston.

Federation Holds First Annual Meeting

Twenty-eight Societies Now Members—Budget Reductions Follow Cut in Assessments

The American Engineering Council of the Federated American Engineering Societies held its first annual meeting in Washington, Jan. 5 and 6, Dean Mortimer E. Cooley of the University of Michigan, president of the Council, presiding. A leading event of the meeting was a dinner in honor of Herbert Hoover, who, addressing the members and guests, praised the work of the Committee on Elimination of Waste in Industry as a great and lasting public service.

After commending the report on the investigation of Waste in Industry, Mr. Hoover cited the problem of electrification as one of the biggest ones confronting the country and suggested a waste survey in this field. Great possibilities lie in the consolidation of the nation's electrical power supply, he said.

NO AGREEMENT ON LICENSING

The Council engaged in a long discussion of the question: Does the American Engineering Council approve of the principle of licensing or registering engineers? Prof. Donald Derickson, of Louisiana, was a leader of the affirmative side. Gano Dunn, of New York, in a spirited speech opposed action by the Council at this time, saying the whole question should be carefully studied before a definite policy was embarked upon. Major F. J. Miller, of New York, Dean Perley F. Walker, of the University of Kansas, and Philip N. Moore, of St. Louis, supported this view, Mr. Moore expressing pronounced opposition to licensing. The Council finally directed the appointment of a committee on licensing to report at the next meeting of the Executive Board.

The Engineers Club of Columbus, Ohio, was admitted to membership at the meeting and there are more than 20 active prospective members, according to Secretary L. W. Wallace, who urged an active and aggressive campaign to secure a much larger membership, stating that "it is evident that the Federation cannot reach the maximum possible attainment until virtually every engineering society is a member." The secretary's report showed that on Jan. 1, 1921, the membership of the society was composed of 6 national and 14 state and local societies, a total of 20. On Dec. 31, 1921, there were 8 national and 20 state and local societies, a gain of 8 member societies representing 1,414 member engineers.

BUDGET REDUCED

Conditions in the mining industry, as stated by Edwin T. Ludlow, president of the American Institute of Mining and Metallurgical Engineers, and Major Arthur S. Dwight, were responsible for a reduced contribution by the institute to the Council for the coming

year. As a consequence, the assessments levied upon the other member societies were cut down proportionately by constitutional amendment. Reductions in the budget were thus made necessary, and, though the Council begins the year with a scarcity of funds, assurances have been given of additional financial aid.

The balloting for officers resulted in the re-election as vice-presidents of Dexter S. Kimball, dean, college of engineering, Cornell University, and J. Parke Channing of New York. W. W. Varney of New York was again chosen treasurer. L. W. Wallace was re-elected executive secretary by unanimous action of the Executive Board.

The Council made provision for a continuance of its national publicity work under the direction of James T. Grady, Director of the Department of Public Information of Columbia University, New York.

The Council voted to co-operate in the movement to prepare for cyclical industrial depressions and unemployment by resort to public works projects. On this subject the Council received a proposal from Mr. Hoover, and it was decided to open conferences with him to ascertain in what way the Council could best provide effective aid.

Topographic mapping and the establishment of a Department of Public Works were other legislative matters in which the Council decided to continue its support.

Considerable discussion was provoked by the plan to establish a Federation journal which would be sent to every engineer enrolled in the Federation. The Publicity Committee made no recommendations and the Council took no definite action. It was generally agreed that some such contact should be established between the Federation and its enrolled membership, but there was sharp diversity of opinion as to its form.

New Representatives

New representatives on the Council were announced as follows: American Society of Mechanical Engineers—Francis Blossom, Charles A. Booth, Gano Dunn, H. H. Esselstyn, W. S. Lee, I. E. Moulthrop, John H. Stevens, A. E. Walden; Society of Industrial Engineers—Prof. Joseph W. Roe; American Institute of Mining and Metallurgical Engineers—C. H. MacDowall (succeeding Prof. Richards); Louisiana Engineering Society—Prof. Donald Derickson; Iowa Engineering Society—Lloyd B. Canfield; Duluth Engineers Club—W. H. Hoyt; Milwaukee Engineering Society—Albert Blatz, Jr.

The executive Board of the Council for 1922 is made up as follows: H. E. Howe, Washington, American Institute of Chemical Engineers; Prof. C. F. Scott of Yale, L. B. Stilwell and Calvert Townley of New York, J. H. Finney of Washington, William McClellan of Philadelphia, and L. F. Morehouse of New York, representing the American Institute of Electrical Engineers; J. Parke Channing and A. S. Dwight of New York, Charles H. MacDowall of Chicago and Philip N. Moore of St. Louis, the American Institute of Mining and Metallurgical Engineers; L. P. Alford of New York, E. S. Carman of Cleveland, Dean D. S. Kimball of Cornell, Prof. A. M. Greene of Troy, Dean Perley F. Walker of Kansas, W. S. Lee of New York, Dean M. E. Cooley of Michigan, American Society of Mechanical Engineers; Prof. Joseph W. Roe of New York, Society of Industrial Engineers; Morris L. Cooke, Philadelphia, Taylor Society; W. E. Rolfe, Associated Engineering Societies of St. Louis; and W. W. Varney, Baltimore, treasurer.

Regional directors chosen for 1922 are: District 1, W. B. Powell, St. Louis; District 2, Gardner S. Williams, Ann Arbor, Mich.; District 4, W. J. Fisher, York, Pa.; District 5, Paul Wright, Birmingham, Ala.; District 6, Lloyd B. Smith, Topeka, Kansas; District 7, O. H. Koch, Dallas, Texas.

Dean Cooley announced that he would begin an extended trip to the Southwest in February.

Indiana Plans Expansion of State Highway System

Seven principal roads may be added to the Indiana state highway system this year, according to Lawrence E. Lyons, director of the department. The new inclusions will connect parts of the system not heretofore connected, or will provide more direct routes between cities or towns. The commission, Mr. Lyons states, will add approximately 300 miles to the system, which now includes 3,600 miles.

300,000-Acre Irrigation Project Under Survey in Nebraska

Surveys of a 300,000-acre irrigation project in Nebraska along the Platte River from North Platte to Kearney, 100 miles long and 4 to 14 miles wide, have been started by the U. S. Reclamation Service, funds to the extent of $30,000 being furnished locally. A number of reservoirs of from 40,000- to 90,000-acre-ft. capacity and 200 miles of main canal are included. No difficult problems, aside from a lack of rock for structures, have been encountered. F. F. Smith is the engineer from the U. S. Reclamation Service in charge.

Propose Uniform Contract Clauses

At a meeting of the Engineering Association of Nashville, Dec. 19, 1921, the following suggestions as to a uniform construction contract was forwarded to the American Engineering Council and Associated General Contractors, to be considered by them in the drafting of a general uniform engineering condition to a contract.

1. A satisfactory arbitration clause should be adopted and should be legally binding on both parties.

2. A definite policy of inspection should be adopted and if two or more separate interests are concerned in payments for work, one authority shall act for all.

3. The contract should specify results, or the method to be followed, but not both.

4. The time of acceptance should be as early and period of maintenance as short as practicable.

5. The contractor should not be held responsible for contingencies beyond his control, and contingencies should be defined.

6. Reasonable limits should be placed upon the engineer's power to increase, or decrease the amount of work to be performed by the contractor.

Arkansas Road Bonds Sell at Par

On Dec. 22, 1921, M. W. Elkins of Little Rock, Ark. purchased an additional $50,000 issue of Spring Lake road bonds at par. This is the second issue of Arkansas bonds within thirty days to be sold at par or better.

City Engineer Sues to Remove His Successor

Suit has been brought in the Circuit Court by Arthur Schneider, who was removed from the office of city engineer of West Allis, Wis., last April, for the purpose of ousting his successor William A. Darby. Mr. Schneider claims that he was appointed city engineer on March 18, 1920, at a salary of $2,500. On March 15, 1921 he was reappointed for the coming year but the appointment was vetoed on April 7, 1921 by Mayor Miller. The veto was upheld by the city council and Mr. Darby was given the position. It is contended that Mr. Darby is not a resident of West Allis and therefore cannot hold office, in which case his appointment becomes illegal.

Iowa Society Six Sections Meet at Sioux City

The Iowa Society of Engineers, composed of four sections and two proposed sections all of which will hold a set of simultaneous sessions, meets Jan. 17-20 at Sioux City. The drainage section will occupy the program at the first day's sessions discussing tile districts, open ditch districts, assessments, subsoil, drainage, laws, levers and pumping plants and the drainage engineer's compensation. The highway section will discuss 1922 bridge specifications, tests, progress records, gravel road construction and maintenance. The mechanicals and electricals have power plant and electrical transportation papers scheduled. Sewage disposal, refuse disposal and activated sludge as applied to the Mason City packing house waste are topics on the program of the municipal section, along with a round table discussion on house connection sizes, sewer grades, and newer pavement types. The proposed railroad section will discuss early days, relation of the engineer to operation and fireproofing of wooden bridges. For the proposed structural-architectural section the program covers building code problems and recent concrete investigations.

At the general sessions much of the time will be given to committee reports on legislation, publication, professional practice, construction costs, standard contracts, services and fees. Other topics are financial problems of the railroads and hydraulic research at the State University. The various engineering clubs in Iowa which are the local units of the society will report on engineering educational requirements.

Coincident with the state society meeting will be a joint session dinner Jan. 18 with the Iowa Section of the American Society of Civil Engineers to which all practising engineers in Iowa and adjointing states are invited. On Jan. 16 the State Board of Examiners will meet in Sioux City.

British Shipyards Plan Bridge Building To Avert Shutdown

(London Correspondence)

Cancellation of warship construction in Great Britain as a result of the Washington conference is a serious thing for the majority of the large naval construction yards. The proposal has been put forward, therefore, that these great works shall devote themselves to the construction of bridges, of which there is a great shortage throughout the country.

Says the Road Board: "There is a very large number of bridges in all parts of the country which will require reconstruction. In every country there is a large number of bridges vested in highway authorities or owned by railway and canal companies which are scheduled as capable of carrying vehicles of only limited tonnage, with the result that a very large mileage of roads, often important roads, are closed to traction-engine and heavy motor traffic until such time as these bridges can be reconstructed."

A recent decision of the House of Lords will have the practical effect of throwing in most cases upon the highway authorities the cost of the reconstruction of weak bridges carrying public roads over railways and canals. It may be roughly estimated that the expenditure necessary to reconstruct bridges on important roads so as to support the motor traffic legalized by Parliament will not be less than £10,000,000; and this is a very conservative estimate.

There is at present a great shortage of adequate bridges on the main arterial roads throughout the country, and several schemes have been put forward recently for additional construction so as to alleviate unemployment. The great armament plants in the country are said to be very interested in the proposal, and there is a movement among local authorities and civil engineers to secure for this branch of construction the expenditure at present allocated to the naval program which would otherwise be absorbed in one of the less remunerative projects proposed by the government for the relief of unemployment.

Would Make River and Harbor Funds on Continuing Basis

Unusual significance is attached to a bill which has been introduced by Senator Jones of Washington, which provides that many of the important river and harbor projects are placed on a continuing contract basis. The bill authorizes the Secretary of War to enter into contracts for such materials and work as may be necessary to complete the following projects:

Ohio River locks and dams, $33,000,000; Southwest Pass Mississippi River, $2,900,000; Los Angeles Harbor, Cal., $1,060,800; Honolulu Harbor, $750,000; Hilo Harbor, Hawaii, $374,000.

Other Important Projects

The bill also provides another group of important projects which are to be formally adopted by Congress and appropriations authorized as follows:

New York and New Jersey channels, $10,400,000; Milwaukee Harbor $4,000,000; Green Bay Harbor, $110,000; Galveston Channel, $670,000; Sabine-Neches waterway, Texas, $1,580,500; Columbia and Willamette Rivers, $1,750,000; Mamaroneck Harbor, New York, $103,000; San Diego Harbor, $225,000; Illinois and Mississippi Rivers, $1,930,000; Calcasieu-Sabine waterway, $500,000; Wilmington Harbor, Delaware, $630,000; Cape Fear, River, N. C, $525,000; Red Lake and River, Minnesota, $15,000; Charlotte Harbor, Florida, $100,000; Wilamette Slough, Oregon, $46,700; Pawtucket River, Rhode Island, $50,000; Plymouth Harbor, Mass., $51,000; Clatskanie River, Oregon, $4,620; Goose Creek, Texas, $5,500; Calcasieu River, Texas, $25,800; Noyo River, California, $16,000; Turtle Bayou, Texas, $16,000.

The secretary of War is authorized by the bill to enter into a contract for the construction of six sea-going hopper dredges for use in harbor work. These dredges are not to cost in excess of $4,500,000.

Authorization also is provided for an annual maintenance appropriation which is not to exceed $17,000,000.

Miami Conservancy Completes Hydraulic Dam Filling

On Dec. 31 the last hydraulic fill was placed in the Englewood dam of the Miami Conservancy District. This is the largest and highest of the Conservancy flood-protection dams, and is the last to be completed; hydraulic filling at the Huffman dam was completed early in December, leaving only two or three thousand yards of team fill to be placed at the south end of the dam. All five of the dams of the district are now finished except for trimming work. The dams have been completed nearly a full year ahead of the original schedule.

The Huffman dam is 3300 ft. long and has a maximum height of 73 ft., an embankment volume of 1,350,000 cu.yd., and a concrete yardage of 40,000. It is located in the Mad River valley, 8 miles east of Dayton. C. C. Chambers is division engineer, J. S. Gena assistant and Verne Clawson superintendent of construction. The Englewood dam 4,700 ft. long and 125 ft. high, contains 3,600,000 cu.yd. embankment. During each of the last two seasons more than 1,000,000 cu.yds. hydraulic fill was placed in this dam. H. S. R. McCurdy is division engineer, H. W. Horne assistant, and Richard Byers superintendent of construction.

Synura Causes Tastes and Odors in New York Water Supply

A growth of synura in the Catskill water supply, New York City, is giving rise to considerable trouble from taste and odors. It is believed that the organisms alone, in the numbers present, would cause no trouble if the water were not being chlorinated; and that the chlorine combines with the oily product of the synura to produce taste and odor, as is the case where waters containing gas works and similar wastes are chlorinated. The matter is being studied by the engineering and laboratory staffs of the Department of Water Supply.

National Housing Problem Before Am. Soc. C. E.

Four Sessions on Economic, Financing, Legislative, City Planning and Zoning Phases

In continuation of its policy for the year 1921-22 of having protracted monthly meetings for the discussion of questions of broad, national scope, the American Society of Civil Engineers, at its meeting in New York City, Jan. 4 and 5, held four sessions at which 17 speakers were scheduled to discuss "The National Housing Problem." The sub-topics and the speakers were as follows:

17 Speakers Scheduled

Broad Economic Phases — Lawrence Veiller, secretary, National Housing Association, New York City; Lawson Purdy, general director, Charity Organization Society of the City of New York; John M. Gries, chief, Division of Housing, U. S. Department of Commerce, Washington, D. C.; John J. Murphy, former tenement house commissioner, City of New York.

Property Improvement and Landscaping—Charles W. Leavitt, civil and landscape engineer, New York City. *Planning and Zoning*—Joseph C. Wagner, assistant director of public works, Philadelphia, Pa.; B. A. Haldeman, chief, Division of City Planning and Municipal Engineering, Pennsylvania Department of Internal Affairs, Harrisburg, Pa.; Charles M. Reppert, chief engineer, Department of Public Works, Pittsburgh, Pa.

House Design — Andrew J. Thomas, architect, New York City.

(3) *Transportation*—Ernest P. Goodrich, consulting engineer, New York City. *Water Supply*—H. M. Pirnie, consulting engineer, with Hazen, Whipple & Fuller, New York City. *Sewage Disposal*—W. L. Stevenson, assistant chief engineer, Pennsylvania Department of Health, Harrisburg,Pa. *Lighting*—F. G. Hibben, representative of the Illuminating Engineering Society, New York City. (4) *Legislation and Financing*—Edward M. Bassett, counsel, Zoning Committee, New York City; Allan Robinson, president, City and Suburban Homes Co., New York; John Ihlder, manager, Civic Development, Chamber of Commerce of the United States, Washington, D. C.; William H. Ham, general manager, Bridgeport (Conn.) Housing Co.

Attendance Ranged from 90 to 15

Notwithstanding this extensive program and the fact that 5,000 invitations had been sent out, the attendance at the first session was only about 90, of which number a large percentage were nonmembers of the society. Each of the three following sessions opened with about 25 present and had a maximum attendance of from 35 to 50, dwindling to 15 before the Thursday afternoon session closed.

New York's housing crisis, according to Mr. Purdy, is most keenly felt by the lowest paid wage-earners, who are forced into crowded, undesirable tenements, now renting for $15 per room per month, as against $5 per room 20 years ago. If the population were distributed, he said, the total taxable values of the city would be increased and living conditions improved.

Figures presented by Mr. Gries showed that, according to the 1920

census, there were 20,000,000 dwellings in the United States (regardless of the number of families housed in each). Roughly 1,000,000 additional dwellings are now needed be believes, to make up the shortage and 350,000 to 400,000 a year are necessary to take care of growth in population and replacements of buildings burned. Standardization of building supplies is much needed; there are now hundreds of sizes and styles of door hinges, window sash, etc. It is reported, Mr. Gries said, that 75 per cent of the houses erected are put up by contractors who build not more than ten houses a year. Under such conditions there cannot be much scheduling of material. Everything is on a small scale basis of production. Building codes also need studying, and this is being done under the direction of secretary Hoover.

Tax Exemption Increased Housing

Speaking of conditions in New York City, Mr. Murphy said that between 1910 and 1918 there were 40,000 apartments and tenements vacant, equivalent to 5 per cent of the total. The State of New York first passed rent-control legislation which deterred the building of houses and then applied a stimulant in the form of exemption from taxation. Since the latter went into effect March 1, 1921, plans have been filed for dwellings to house some 56,000 families in New York City, or five to six times the number filed in the previous year. The reported cost of these houses is $260,000,000. Three-fifths of the new housing being provided in New York is one and two-family houses, and the rest tenements. The recent advance in freight rates, according to Mr. Murphy, has added some $250 to the cost of the average house in the United States.

Mr. Veiller dealt particularly with the slum which, he says, prevails in cities, large and small, throughout the United States and is worse here than in other countries.

City Planning and Zoning

Mr. Leavitt reported a strong tendency in the Borough of Queens, New York City, and in Westchester County, N. Y., to build a good grade of one-family houses on small lots.

The three papers on planning and zoning by Messrs. Wagner, Haldeman and Reppert pointed out that zoning provides the maximum of benefit for the minimum of effort and cost in city planning work and is rapidly growing in favor. Zoning has an important effect on the economy of street layouts and the design of utilities. The industrial area requires an altogether different street layout, with fewer but more capacious streets, than other areas of the city. The business area needs more streets than the industrial. Heretofore subdivisors of property have acted wholly in the interest of landowners in order to give them the most profit. There is need now for city planning that will give the greatest benefit to the greatest number. Existing conditions cause strangulation of traffic.

In his talk on house design, Mr. Thomas presented an old style and a new style plan for housing 32 families on a lot 100x100 ft. The old style dumb-bell plan occupied 79 per cent of the area of the lot and the new style, or approximately U-shaped plan, occupied only 62 per cent and could be built for $40,000 less than the old style and would rent better. Nevertheless, he found it impossible to secure financing of the new style plan because all the loaning institutions were following the arbitrary practice of basing loans on cubical contents of tenement blocks.

Transportation and Other Utilities

Under the topic "Transportation," Mr. Goodrich laid stress upon the possibility, by the aid of zoning, of enabling the majority of city dwellers to get from their homes to places of work and amusement by walking, or at least without the need of rapid transit facilities.

The addresses on water supply, sewerage, and lighting by Messrs. Pirnie, Stevenson, and Hibben necessarily went over familiar ground though with particular regard to the relation of these services to the house and householder.

Under the subtopic, "Legislation and Financing," Mr. Bassett said that the lowest cost of decent homes for working men in the Borough of Queens, New York City, today is $6,000.

Mr. Ham said that housing today is in disorder, especially as to financing, in which double protection to those who loan money is demanded. House construction itself is on a very uneconomical basis. Excavation work is done mostly by hand labor. Small machines adapted to the work are needed. Foundations should be of unit construction material. The timberwork design of houses is bad. Studding is still placed 16 in. c. to c. because of the limitations in the length of lath cut from poor lumber. Plastering by the wet process is wrong because it brings moisture into the building and does damage. In this and other ways present methods of plastering are one of the greatest causes of house depreciation. A dry plastering method should be adopted and more paneling should be used. Pipe for plumbing is cut by hand on the job whereas by means of standardization it could be simplified and lessened in cost. There should be more fabrication of house parts in shops near the site of building operations.

Mr. Ham proposed that the American Society of Civil Engineers, the American Institute of Architects, the American Society of Mechanical Engineers, and various financial and other institutions should appoint a joint committee to study the whole housing problem and that the American Society of Civil Engineers should employ a high-class man as director of the study.

Consolidation of N. Y. State Engineer and Other Offices Urged

Constitutional amendments enabling the Legislature of New York to consolidate and reorganize two or more of the state departments having to do with engineering and allied work are recommended in the annual message of Governor Nathan L. Miller. He declares it his opinion that "economy and efficiency would be promoted by a consolidation of the department of public works and the state engineers' office and possibly by including . . . the department of highways, state architect and department of public buildings." The first two departments of those named are prescribed by the state constitution.

American Concrete Institute Announces Convention Program

Preliminary announcement has been made of the tentative program of the convention of the American Concrete Institute to be held at the Hotel Winton, Cleveland, Ohio, Feb. 13 to 16 inclusive. Sessions in the afternoon of the first day, Feb. 13, will be on concrete roads and in the evening on concrete houses. Feb. 14, the morning session is devoted to research work and the afternoon and evening to concrete products.

On Feb. 15 the morning session will be devoted to practical field problems and the afternoon to design.

On Feb. 16 there will be a general discussion of the report of the Joint Committee on Concrete and Reinforced Concrete, which will be taken up by major subjects and will be specially discussed by the chairman of the Institute standing commimttees whose work involves special consideration of the subjects covered in various sections of the Joint Committee report. The discussion will be continued in the afternoon. In the evening of the 15th there will be an informal entertainment and get-together meeting.

The secretary of the Institute is Harvey Whipple, 314 New Telegraph Bldg., Detroit, Mich.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Cleveland, Ohio, Feb. 13-16.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Conference, Cleveland, Ohio, Jan. 17-19.

The Illinois Section, American Society of Civil Engineers, at its annual meeting Dec. 21, elected the following officers: President, A. J. Hammond, new vice-president, T. L. Condron and secretary-treasurer, W. D. Gerber. The hold-over vice-president is J. N. Hatch.

The Kansas Engineering Society elected the following officers at its annual meeting held Dec. 22: President, Lloyd B. Smith; vice-president, P. L. Brockway; secretary-treasurer, J. M. Averill; directors, H. S. Putney; P. J. Ruckel.

The Idaho Chapter, A. A. E., the Idaho Society of Architects and the Idaho Irrigation Congress, will hold a joint convention in Rupert, Idaho, January 16-21. Names of speakers and topics will be announced later.

The Seattle Engineers Club at a recent weekly luncheon listened to an address on "Aircraft from an Engineering Standpoint" by J. W. Miller of the J. W. Miller Aircraft Co.

The Seattle Post, American Society of Military Engineers recently elected

the following officers: President, Major O. A. Piper, Seattle; vice-president, Major Charles Wild; secretary, Captain K. M. Dean, Seattle; treasurer, Major A. B. Cutter, Everett.

The **Engineers' Society of Pennsylvania** will hold a reunion of all members and former members on January 14, at 8 p. m. at the club house in Harrisburg.

The **Providence Engineering Society** will hold a regular meeting Jan. 18 instead of Jan. 17, as planned. The change in date is being made to accommodate L. W. Wallace, vice-chairman of the Hoover Committee on Elimination of Waste in Industry, who will summarize the results of this work of the Federated American Engineering Societies.

The **Western Society of Engineers'** January schedule of meetings includes the following papers: Jan. 9, "The Design of the Akron (Ohio) Viaduct," by Louis R. Ash, consulting engineer; Jan. 14, "Sources of Technical Information," by Miss E. V. Savage, librarian of the society; Jan. 16, "Co-operation between State and Consulting Engineers," by C. M. Baker, engineer, Wisconsin State Board of Health; Jan. 25, "Experience with Treated Timber in Bridges," by A. F. Robinson, bridge engineer, Santa Fe System. The last is a joint meeting with the American Wood Preservers' Association. An inspection of the Underwriters' Laboratories to witness special tests of fire resistive material is planned for Jan. 24.

PERSONAL NOTES

W. L. SAUNDERS, New York City, representing the American Society of Mechanical Engineers, has been appointed a member of the board of trustees of the United Engineering Society for a term of three years, expiring in 1925. He succeeds Irving E. Moultrop, whose term expired.

JAMES E. GILLESPIE, formerly division engineer for the Wisconsin Highway Commission has entered private practice as a highway engineer in Oshkosh.

J. WALTER ACKERMAN, formerly city engineer of Auburn, N. Y., has been appointed city manager of Watertown, N. Y., succeeding C. A. Bingham, resigned. Mr. Ackerman has been superintendent of the water, light and power department in Watertown since June, 1920.

GEORGE M. COUGHLIN has recently been chosen director of public works of Bridgeport, Conn., succeeding Jacob A. Courtade.

JOHN H. BARR, of New York City, has been appointed to represent the American Society of Mechanical Engineers on the Engineering Foundation Board for the term expiring in February, 1925. He succeeds Dr. W. F. M. Goss.

JACOB A. COURTADE, for the past twelve years director of public works of Bridgeport, Conn., has resigned to accept a position as Connecticut manager for Warren Bros. Co., Boston.

JACOB RITTER, of Ft. Wayne, Ind., who for the past year and a half has been engineer in charge of production for the Visible Pump Co., has been appointed distributing manager for that company with headquarters at Detroit.

HAROLD R. HOLMES, city engineer and building inspector of Lockport, N. Y., has been reappointed by Mayor Crosby at a salary of $2,700 for the year.

ALFRED M. LUND and PHILLIP B. HILL, consulting engineers, Little Rock, Ark., have dissolved partnership. The business will be continued by Mr. Lund. Mr. Hill will practice engineering in Little Rock.

F. W. ULLIUS, JR., WILLIAM E. SKINNER and RALPH M. KIBBE have incorporated as consulting engineers under the name of The Associated Engineers, Inc., Milwaukee. Mr. Ullius, the president, is the village engineer of Shorewood and a member of the metropolitan sewerage commission of Milwaukee County. Mr. Skinner, vice-president and manager, was formerly with the electrical department of the Chicago, North Shore & Milwaukee R.R. Mr. Kibbe, secretary and treasurer, was with the Albert Trostel & Son Co.

LESLIE E. PROUTY has been appointed county engineer, Mobile Co., Ala., succeeding S. M. Adams.

NORMAN F. BROWN, director of the department of public works of Pittsburgh, Pa., has become vice-president of the Dravo Contracting Co. succeeding the late John J. Nolan.

JAMES LOGAN, for the past ten years county engineer of Burlington Co., N. J., has resigned to enter private practice at Mount Holly. E. HAROLD WILLIS of Mount Holly, N. J., has been appointed successor to Mr. Logan.

AMBROSE SWASEY, of Cleveland, has been selected to succeed himself on the John Fritz Medal Board for the term expiring in February, 1925.

GEORGE W. BATCHELDER, water commissioner, Worcester, Mass., has been re-elected by the common council.

J. C. HOLMAN, formerly in charge of the cost engineering department for the U. S. Housing Corporation at New Brunswick, N. J., has been elected vice-president of the A-J Contracting Co., Inc., New York.

GEORGE M. WISNER, formerly chief engineer, Sanitary District of Chicago, and retained for a time as consulting engineer, has been reinstated as consulting engineer to handle the lake-level problem.

CASPER D. SHAWVER has been appointed city engineer Cheyenne, Wyo. In 1905 he was with the U. S. Reclamation Service in Montana where he assisted on the Huntley and Blackfeet projects. Later he served as assistant city engineer in Sheridan, Wyo., for four years. From 1915 until 1920 Mr. Shawver was deputy state engineer of Wyoming. During the World War he resigned to serve at Camp Lee, Va., where he was commissioned captain. After the armistice he returned to Wyoming where he found his position in the State House awaiting for him. He resigned in 1920 to take charge of an irrigation project in Western Wyoming.

Celebrate Start of Work on Delaware River Bridge

The starting of construction on the Delaware River bridge at Philadelphia was celebrated on Jan. 6 by formal first-spade exercises, in which Governor Sproul of Pennsylvania, Governor Edwards of New Jersey, and Mayor Moore of Philadelphia joined. Earth was not available for actual spade work but planks were pried out of structures to be demolished, with the aid of silver-plated picks and crowbars wielded by the officials.

The contract for the two main piers was awarded last week to Holbrook, Cabot & Rollins and the Keystone State Construction Co. on their joint bid, which was the lowest of those submitted, as reported in Engineering News-Record, Dec. 22, p. 1040.

Bids have been asked for the demolition of buildings on the site of the Philadelphia anchorage. They are to be opened Jan. 11.

The superstructure plans are practically complete, it is understood. A slight modification of the roadway construction is the only essential departure from the plans presented in tentative form at the time the Board of Engineers rendered its preliminary report last May (Engineering News-Record, June 23, 1921, p. 1086).

OBITUARY

CLIFFORD M. KING, assistant engineer in the sanitary department of the city engineer's office at Cleveland, Ohio, died Jan. 2 in that city. Capt. King was born in 1879, graduated from Western Reserve University in 1901 and as a civil engineer from Cornell University in 1904. His early practice was in the irrigation work in the Far West, but in 1908 he became city engineer of Sandusky, Ohio. He served overseas with the 528th Battalion of Engineers in 1918. On his return he entered the city engineering department of Cleveland. Capt. King was also in the Spanish-American War in the Ohio National Guard.

H. CLAY KELLOGG, construction engineer, died at Santa Ana, Cal., Dec. 23, at the age of 66. He was engineer for the Anaheim and Santa Ana valley water companies. He laid out the towns of Elsinore and Corona, Cal., and built a railroad from Riverside to San Bernardino. He also supervised dam construction work in Hawaii and had been consulting engineer on many irrigation projects, in which he specialized in later years.

JOHN ARMSTRONG GEORGE, formerly city engineer of East Liverpool and Wellsville, Ohio, died suddenly Dec. 5. He was born in Allegheny County, Pa., in 1839 and came to Wellsville 45 years ago to supervise the construction of the first water-works. Although 82 years old Mr. George was engaged in engineering practice to the day of his death.

WILLARD WELLS HERETH of Indianapolis, Ind., died recently at Butler, Pa. At the time of his death he was traveling as efficiency engineer for the American Water Works and Electric Co. He was a graduate of Purdue University, class of 1919.

Business Side of Construction

Facts and Events that Affect Cost and Volume

New England Contracts Let in Last Quarter

Indicative of immediate engineering construction prospects in New England, *Engineering News-Record's* Construction News has announced contracts let to the value of over $20,000,000 in October, November and December, 1921. Contracts for commercial buildings worth $150,000 and over aggregated $15,313,753; industrial works of $40,000 and more, $2,890,000; streets and roads, $2,000,000; other public works, $124,000. These figures are of course for prospective actual construction and do not include the large amount of projected work that has not yet reached the contract-awarded stage.

Materials Stocks in Thirteen Cities

Stocks Restricted in Anticipation of Freight Reduction, but Sufficient to Meet Demands

New York — Common brick on hand to the amount of thirty-four barge loads within city limits. These are quoted on open market for immediate use and are not being held as covered cargoes. Small stocks of hollow partition tile on hand. Material shipped in by lighter in 100 ton cargoes from factories within 26 miles of city; 48-hr. deliveries to contractors within Metropolitan District. Not overstocked on sewer pipe but deliveries can be made in less than a day. Sufficient supply to meet all contractors' demands for the present. Dealers' stocks of sand, gravel and crushed stone, within city fairly large. Lumber yards able to complete delivery on quantities of yellow pine as large as 300,000 ft. b.m. in 9 or 10 days within Metropolitan district. Cement stocks fairly large; 5,000 to 6,000 bbl. kept on hand by one dealer alone. Deliveries in less than 24 hr.

Minneapolis — Lumber stocks lower than usual. About 3,000 bbl. of cement in local warehouses, but unlimited supply available in nearby mills, where cars are loaded the same day orders are received. Brick stocks as low as they are allowed to get, but supplies in any quantity can be had from yards within one day's shipment from the Twin Cities. Lumber stocks about 20 per cent below normal.

Denver — Cement shipments within 48 hr. from mills near city. About 1,000 tons of structural shapes on hand. Approximately 7,000,000 brick in stock; local plants can make 24 hr. deliveries. About 5 cars of asphalt on sidings. Lime stocks exceeding 500 bu. are not kept by any dealers. Sand and gravel delivered in 12 hr. from local pits.

Detroit — Plenty of sewer pipe on hand; very little demand. Other materials stocks sufficient to complete present contracts. Cement available at nearby mills.

Cincinnati—Ample stocks on hand in principal materials. Granite paving blocks not kept in stock but 50,000 daily can be supplied on three days' notice.

Boston—Fairly large supply of building materials. Ample supply of sewer pipe, all sizes, up to 24 in. All deliveries prompt.

Montreal—Stocks or hand larger than demand. Large retail stocks of lumber; mill deliveries from 1 to 2 weeks. About 15,000 tons of structural steel in stock; 24 hr. deliveries.

Chicago — Manufacturers' stocks of expanded metal lath larger than normal; dealers stocks lower. No stock of reinforcing bars carried, but manufacturers can supply any job, within city, in 10 days. Cement stock about 50 per cent normal. Immediate deliveries on lime, common brick and sewer pipe. Hollow tile delivered in 1 to 6 days.

San Francisco—Small stocks of common brick and cast-iron pipe. No railway ties on hand. Structural materials, lumber, cement and hollow tile kept in fairly large quantities. Unlimited amount of lime in stock. Deliveries in 2 to 3 days.

New Orleans—Ample supply of lumber on hand; one thousand car loads could be delivered daily within 5 days notice. Brick stocks unusually large. Cement stocks moderate but the daily consumption of 1,000 bbl. is equaled by the daily receipts from the mills. Sewer pipe stocks low; no demand. No stock of creosoted wood blocks on hand and none is expected until the 1922 paving program has gotten fully under way.

Philadelphia—Sewer pipe stocks kept low awaiting adjustment of freight rates. Asphaltum holding up better

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Boston, 8,000 bbl.); time required for delivery of carload lots to city job, example: (cement, Birmingham, 1 to 2 days); and stocks on hand in general terms, example: (sewer pipe, Detroit, plenty.)

	New York	New Orleans	Denver	Detroit	Minneapolis	Cincinnati	Chicago	Boston	San Francisco	Birmingham
Sewer pipe.....	Sufficient Del. in 1 day	70 car loads	Ample	Plenty	.....	6,000 ft.	200 carloads	Large supply	Good; del. 2 to 3 days	Plenty
Cement.....	6,000 bbl. one dealer alone	30,000 bbl.	7,000 bbl. 48 hours	100,000 bbl.	3,000 bbl. 24 hr. from mills	8,000 bbl.	Del. few hrs. 50 per cent normal	8,000 bbl.	6,000 bbl. del. 2 days	2,000 bbl. del. 1 to 2 days
Lime (common)	Ample	.....	4,000 bu.; del. Missouri lime 10 day to 2 weeks Colorado one week	Plenty	Plenty	.....	50 cars; can supply any job in few hours in the common or hydrated	2,000 bbl. 5 to 8 days	Limited 3,000 bbl. del. 2 to 3 days	4,000 bbl.
Lime (hydrated)	Ample	.....		Plenty	Plenty	.....		175 tons; 5 to 8 days		Inc. in above
Common Brick.	34 barges	50 cars; produce 10 carloads daily	7,000,000 24 hours	Sufficient	3,500,000, 24 hour from yards	10,000,000	150,000,000	150,000	Small; del. 7 to 10 days	Plenty
Hollow Tile....	Small; 48 hr. del. from factory	.....	.....	Moderate	.....	.....	Del. 1 to 6 days	.....	Good; del. 2 to 3 days	Plenty
Lumber.....	Can complete del. on 300 M ft. in 9 or 10 days	Can deliver 1,000 carloads daily within 5 days	16,000,000 ft.	10,000,000 ft.	44,000,000 ft.	100,000,000 ft.	Large stocks; immediate delivery	Large stocks; spruce 10 to 14 days; pine 4 to 6 weeks	40,000,000 ft. del. 30 days	Large mills within 200 miles

Year End Lumber Demand Steady

Reports for week ending Dec. 17 from producing lumber associations to the American Wholesale Lumber Association indicate that the demand after the previous week's increase has been maintained. The customary drop at the end of the year has not yet shown in the statistics. With production about 3 per cent of normal orders are running 64 per cent of normal and shipments 66 per cent of normal. The great demand for timbers in Japan increased water shipments in 1921 to 208,000,000 ft., 2½ times what it was in 1920.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 9@20 are the following:

A bridge for Sanitary District of Chicago, $1,000,000.

A hotel at Atlantic City, $5,000,000.

An office building for Chicago, $7,000,000.

Next week—Representative Public Bond Sales in December

than usual for this time of the year. Paving stone and wood blocks low. Brick and hollow tile very light. Lumber stocks below normal; but will be replentished beginning with the first of the year.

Baltimore — Plentiful supply of all materials excepting explosives. Deliveries on dynamite in about one week.

Atlanta — Plenty of pine lumber, cement and common brick. About 5 to 8 cars of lime on sidings and deliveries on tile made in 3 to 4 days.

Trend of Business

Bonds—Market duller than in previous weeks, probably owing principally to year-end adjustments. Resumption of high activity expected soon. The largest individual public bond sale last week was $20,000,000 of Ohio 4¾s. to yield 4.40 to 4 per cent, according to maturities ranging from 1923 to 1932. A large block of Michigan 20-year 5½s changed hands above 114, which is a 4.40 per cent basis. The 3½ per cent tax exempt Liberty bonds advanced to 96.28 on Jan. 9, the high mark last year being 96.7.

Stock Market—Dull, with prices lowering, despite cheap call money.

Money—Call loans were renewed at 4 per cent and finally at 3 per cent, on Jan. 9, the former rate being the lowest since the autumn of 1919. Time loans at 4½ to 5 per cent.

Foreign Exchange — Sterling, $4 22⅝, highest since Dec. 12; franc, 8.28¼ cents; mark, .6 cent.

Iron and Steel—Pig iron production in December was 1,649,086 tons, against 1,415,491 in November; but steel production was 232,908 tons less in December, capacity in operation being only 45 per cent. Iron and steel output in 1921 was smaller in relation to capacity than in any previous year. About 19,000,000 tons of steel ingot were produced (on 38 per cent capacity), compared with nearly 40,000,000 in 1920.

Unemployment decreased in December in textiles, iron and steel, lumber, leather, paper and printing, metals and metal products, but for all industries decreased 4.7 per cent, according to the U. S. Employment Services and telegraphic survey of 1,428 firms in 65 industrial centers. The decreases were mainly in the food industries, beverages, chemicals, ceramic, vehicles for land transportation, and in railroad repair shops.

Large Contracts Let

Among this week's announcements of contracts awarded in Construction News, pp. 9@20 are the following large projects: A 12-story bank and office building in Los Angeles, Cal., to Lange & Bergstrom, Washington, Bldg., $1,500,000; a 15-story office building in Detroit, Mich., to M. Harrison and L. A. Turnock, 500 Board of Trade Bldg., Indianapolis, Ind., $1,650,000; a 12-story office building in Chicago, Ill., to Leonard Construction Co., 37 South Wabash Ave., $2,500,000; an oil refinery and asphalt plant in Linden, N. J., to J. Ferguson, United Bank Bldg., Paterson, N. J., $2,000,000; a freight terminal at Denison, Tex., to C. R. Cummins Co., Cleveland, O., $3,000,000.

Labor to Drop Restrictive Working Regulations

New York Building Trades Council to Accept Suggested Modification—Wage Schedule in Doubt

Interest in the building trades situation in New York City is centered about (1) a discussion of the wage schedule for 1922, and (2) the elimination from union regulations of certain objectionable practices. As to question No. 1, little has as yet been done. The elimination of certain practices from union regulations has been agreed upon by Samuel Untermyer, counsel for the Lockwood Committee, and the Building Trades Council.

Practically the only concrete thing so far in the settlement of the wage question is the plan set forth by the Building Trades Employers Association whereby a representative committee, which would form a public group, would negotiate a 1922 schedule of wages with the Building Trades Council. The employers association would agree to abide by the decision of this public group and the council. The employers suggested that such a public group be composed of one representative each of the American Institute of Architects, the American Federation of Labor, the New York State Chamber of Commerce, the New York City Merchants Assn., and one appointee of the governor of New York. The union objected to such a body on the ground that it would be practically all open shop or at least inimical to labor interests. So far no counter proposal has been made. In the meantime the employers association has circulated among its membership a notice that the 1921 schedule of wages shall endure until Jan. 31, 1922.

Objectionable Practices Cited

The elimination of certain objectionable practices from union regulations is the result of testimony brought forth in the investigation of building conditions in New York City being prosecuted by the Lockwood Legislative Committee on Housing. After rather a comprehensive survey of the situation had been made by the committee, Samuel Untermyer set forth nineteen of the practices which he considered most unreasonable and which should be immediately done away with. In general the regulations are to be adjusted along the lines of Mr. Untermyer's suggestions, which follow:

1. Membership restrictions in the various unions must be removed.

2. Membership dues shall not exceed $50.

3. Restrictions upon the number of apprentices in the various trades must be repealed.

4. The issuance of permit cards to non-union men so as to allow them to work with union men must be forbidden. The acceptance of such non-union men into union organizations will automatically eliminate this objection.

5. Accurate account books of the various unions and the general union organization must be kept, and must be certified at regular intervals by public accountants.

6. Unions must dispossess themselves of the power to fine employers under penalty of refusing to supply them union labor. The investigation showed that employers have been fined for allowing painters to fill in plaster cracks when the latter were painting walls and ceilings, and that other employers have been fined for poor work done by union men.

7. There shall be no discrimination in supplying to members of the employers association labor over non-members of the association.

8. The activities of union organizations must be restricted to matters that legitimately concern themselves. There must, for instance, be no dictation from union men or from union organizations as to the character of the employer's contract. There shall be no insistence that a contract for labor call for a contract to supply materials.

9. There must be amendments to eliminate an extraction of penalty from employers, such as a requirement that an employer pay one-quarter of a day's wages to each man in a group because all were held up ten minutes when waiting for pay. This instance was testified to at one of the hearings before the Lockwood committee.

10. The restrictions upon the use of mechanical appliances must be removed as well as the restrictions against the fabrication of certain materials on the job instead of in the shop, where it is believed rightly to belong. The committee found that one of the most objectionable practices of this nature was the refusal of unions to install or handle the anti-siphon trap, although its use was authorized by both city and federal authorities. The committee also found that unions were not permitting the installation of plumbing with fixtures attached in the shops.

11. The penalties against employers for "rushing" or "driving" must be eliminated.

12. The power of unions to prohibit members from working more than 5 days per week, or to fine members for working any other day than Sundays and holidays is also found unreasonable.

13. Delegates or business agents convicted of extortion and who have served prison terms should be made ineligible to hold similar posts.

14. Regulations should be enacted prohibiting any union or business agent from outlining or enforcing a daily detail of work.

15. The following matters in relation to plumbing work should be abated:

a—That there be but one helper to two plumbers.

b—That no helper can use the tools of a plumber except when the mechanic himself is idle.

16. The provision of the cement masons that, where two men are used one must be a foreman, and in case four or more are used the foreman shall not use any tools, must be repealed.

17. The rule requiring employment of metal lathers wherever concrete is being poured by common labor that compels the employment of a foreman to look on while work is being done, although there are no lathers and there is nothing for the lather to do, is unreasonable. Also, that if one man is employed he must be a foreman, is an unreasonable regulation.

18. The regulation that the rate of wages paid to painters must be the same as the rate prevailing in the city wherein the contractor has his office, if that rate be higher than where the work is done, should be done away with.

19. The limitation of painter apprentices in shops is unreasonable as is the limitation on the size of the paint brush used on the job.

Although these are the basic objections it is possible that certain revisons will be made before a final settlement is agreed upon.

From time to time we will publish prices of materials and labor rates and conditions in cities other than those covered weekly and monthly in Engineering News-Record. Next week—the Buffalo market.

Some Costs in Colorado County, Tex.

B. H. Faber, County Engineer of Colorado County, Tex., advises that road gravel and wash sand cost 75 cents per cu.yd., wash gravel $1.50, f.o.b. county pits. Labor is plentiful—$1.50 for negro, $2@$3 for white, per 10-hour day.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of January 5; the next, on February 2.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb.	—$2.63	—$3.50	$4.00	$2.88	—$2.91	—$3.50	$3.45	$3.85	$4.00
Structural rivets, 100 lb.	3.50	—5.00	5.50	3.43	—3.90	4.25	—4.50	—4.00	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	—2.53	3.20	3.50	2.68	—2.81	3.57½	3.00	3.75	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	57.65%	45%	57%	61.9–5%	41%	53.7%	55%	35.10
Cast-iron pipe, 6 in. and over, ton	47.30@48.30	45.00	—48.30	44.10	47.80	52.00	50.00	55.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.30	—2.55	2.55	1.97	—2.24	—2.90	2.84	—2.94	—3.10
Gravel, ¾ in., cu.yd.	1.75	1.85	—2.00	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.00	1.25	—2.00	2.00	.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	—1.75@1.85	2.00	—2.93	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	49.00	—35.00	34.00	—43.00	36.00	50.00	+32.00	—19.00	78.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	18.00	29.00	30.00	22.00	27.00	21.00
Lime common, lump, per bbl.	3.00@3.49	1.50	2.75	1.40	1.40	2.95	1.90	2.75	11.00
Common brick, delivered, 1,000	—17.40@17.90	9.00	—12.65	11.00	—15.00	14.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.0675	.13	.0821	—.0752	— 08	.12½	.10	.08@.29
Hollow partition tile 4x12x12, block	.11120	.0675	.13	.0657	....	.10	.14½	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.72	.78	+.93	+.76	.80	.90	+.83	.79	.85
Common Labor:									
Common labor, union, hour	.75	.35	.....	.72½	.50	.50@.55	—.62½	.50@.60	.....
Common labor, non-union, hour	.....	.20	.35@.45	.35@.40	—.40@.50	.35@.40	.56¼	.50—.20@.30	

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd. **Chicago** quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.45 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. **Dallas** quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. **Seattle** quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net. **Montreal** quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile, per ft. Cement price is in Canadian funds (the Canadian dollar stands at 94 cents). Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. **Steel pipe** per 100 ft. net.

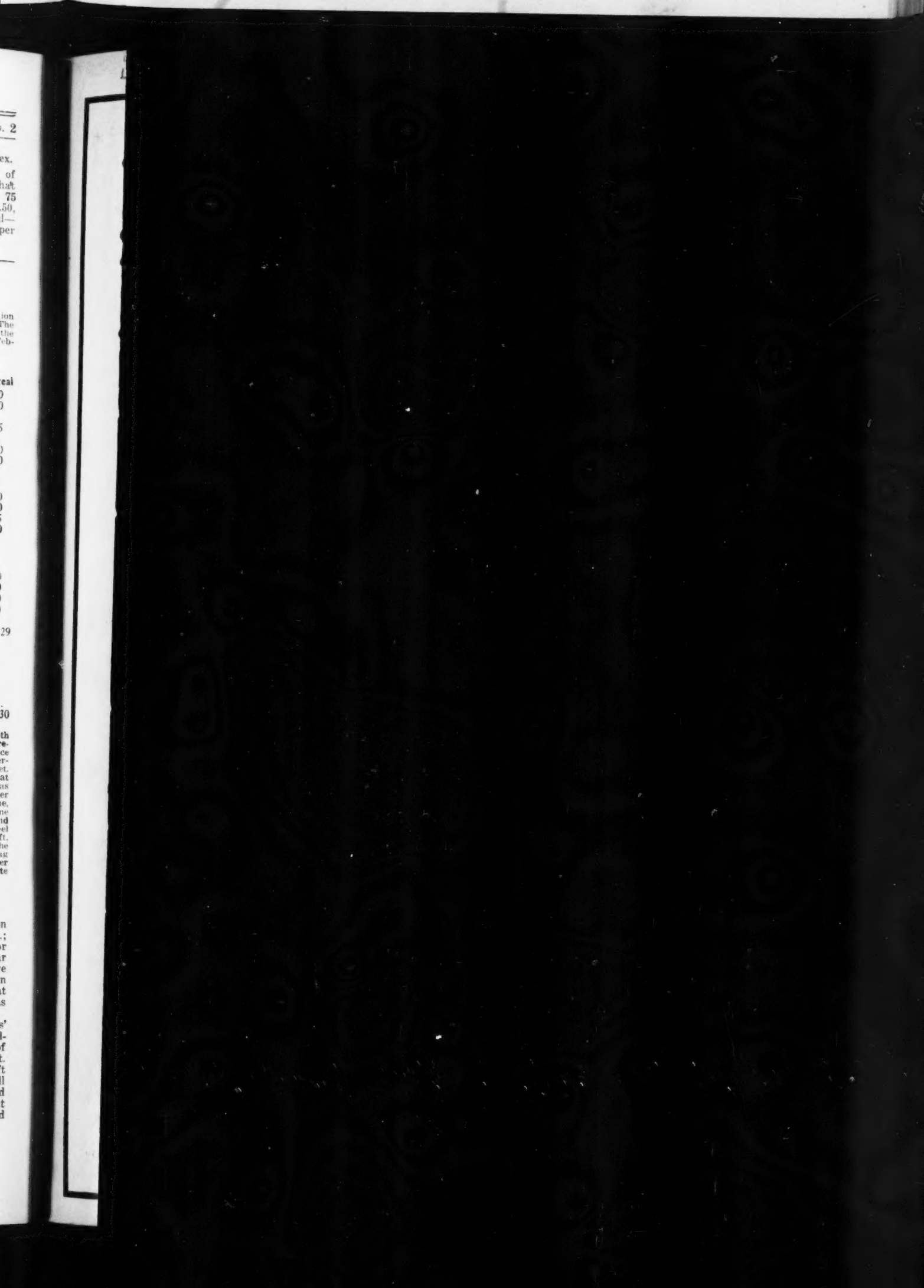
Changes Since Last Week

Reductions averaging about 18c. per 100 lb. on steel shapes, at the warehouse, are quoted in New York, Atlanta, Denver and Minneapolis; average drop of 25c. on structural rivets in Atlanta, Minneapolis, San Francisco and Seattle. Reinforcing bars down 15c. in New York and Minneapolis. Structural steel continues to be quoted at $1.50, Pittsburgh, in large tonnages; mill shipments, New York, at $1.88 for shapes and bars and $1.83@$1.88 for plates. Mill shipments, Denver, of structural shapes are quoted at $3 per 100 lb. Lower prices due principally to reduced cost of production.

Price of cement reduced 14c. in Atlanta; 20c. in Denver; 16c. in Seattle and 2c. per bbl. in Montreal. Dallas quotes reduction of 25c. per cu.yd. on sand, gravel and crushed stone; New York quotes ¾-in. crushed stone at $1.85 as against $1.90 and 1½ in. at $1.75 as compared with former price of $1.80 per cu.yd. Long leaf yellow pine, base sizes, has advanced $2 per M. ft. b.m. in San Francisco yards.

Common bricks are quoted in Minneapolis at $15 as against $17 and in New York at $14@$14.50 as compared with the recent price of $14@$15 per 1,000 wholesale. Slight drop in hollow building tile in Denver and Minneapolis.

Linseed oil up 5c. in Dallas, 2c. in Chicago and 1c. per gal, in San Francisco.

The decision of the Impartial Wage Board of the Industrial Association of San Francisco has rated union common labor at $5 per day or 62½c. per hr.; unskilled non-union at $4.50 per day or 56¼c. per hr. Although the regular rates for non-union common labor have been 50c. in Minneapolis and 30c. in Montreal, men are now procurable at 40c. in the former city and at a rate as low as 20c. per hr. in the latter.

The National Lumber Manufacturers' Association's report for the week ending Dec. 31, 1921 shows a total of 102,504,166 ft. cut; 113,113,745 ft. shipped and orders for 118,048,343 ft b.m. Mills reporting, representing all members of the Association, numbered 350. Production for the week was about 51 per cent; shipments 47 per cent and orders 43 per cent below normal.